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Chemism of Melting of Soda-Boro-Silicate Glass

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I.

THE melting of glass, which is one of the most important processes in the manufacturing of glass, could be rationalized only if we knew to a sufficient degree how this process is being carried out from the physical and chemical point of view. The rationalization of glass-melting must therefore begin with a scientific basing of the process. Notwithstanding the great importance of such a study, without which it is difficult to put the question of a rational method of glass melting, as yet very little has been done for it. We can enumerate only a few works dealing with this subject. Undoubtedly, the proximate problem in glass technology is the study of the chemism of melting of different glasses, that is to say, the study of the conditions of reaction of various components of the batch at different temperatures and of the obtainment with them of a homogeneous melt called glass.

Cobb[1] seems to have been the first to study the processes of glass melting. His object was to investigate at various temperatures the conditions of reaction of the separate components of a batch of lime-soda glass. His system consisted of silica, soda and lime and corresponded with the following composition of glass in oxides:

$SiO_2 = 83.6\%$
$Na_2O = 8.6\%$
$CaO = 7.8\%$

which answered the following molecular formula: 10 SiO_2, 1 Na_2O, 1 CaO.

By certain methods of chemical action on the melts he succeeded in fixing separate stages of the reaction during the melting of glass.

After him Niggly[2] studied a system composed of silica, potash and lime. As he did not undertake this research from the point of view of the technique of glass-manufacturing, he would choose batches very remote as to their composition from the ordinary commercial glasses, and study the conditions of reaction on a comparatively small temperature range (864°—932° C.). Five batches of the following composition underwent this investigation.

	SiO_2	CaO	K_2O
1.	10.8%	33.2%	56.0%
2.	6.2%	24.6%	69.2%
3.	14.5%	14.2%	71.3%
4.	10.1%	8.8%	81.3%
5.	10.9%	8.8%	80.3%

The particularity of his work was that he applied the microscopic method to the study of the melts and determined crystallographically the formations in the melts due to the reaction of the components.

Among the latest works in this domain the research of Professor G. U. Jookovsky offers an exceptional interest; he studied, as well as Niggly, a system of silica, lime and potash, but differently from Niggly, he chose such a correlation of components in the studied batch as corresponded with the ordinary types of commercial glasses, and that is why the whole work offers a considerable interest for glass manufacturers. Professor Jookovsky's research entitled "Temperature conditions of reaction of the constituents of a batch of lime-potash glass" was read by him January last at the Institute of Silicates in Moscow at a conference of works-laboratories of the glass industry.[3] His batch calculated as ready glass in oxides consisted of 70% of SiO_2, 13% of CaO and 17% of K_2O.

The temperature interval was much larger than with Niggly and extended from 500°C. up to 1000°C. The melts were investigated chemically, i.e. subjected to attack by alkaline and acid solutions under certain given conditions. In this way it was possible to fix the beginning of reactions between separate components of the batch, the temperature of the complete melting of the batch and a set of data in the

[1] Zschimmer, "Theorie der Glasschnelzkunst als physicalisch-chemische Technik," B. II (Erster Teil), s. 128-132; 1923.
[2] Zschimmer, Ibid, p. 132-137.

[3] A concise review of the proceedings of the conference was given by one of us in No. 1 of the journal, "Keramica i Steklo," 1929, Moscow.

melting process, which offer a considerable interest for the manufacturer.

The following investigation, carried out by us at the laboratory of the glassworks "Drushnaya Gorka," is an attempt to study the chemism of melting of one of the glasses used in glass manufacturing. We selected a soda-boric acid silica glass, possessing a very low coefficient of expansion and consisting of 25% of B_2O_3, 65% of SiO_2 and 10% of Na_2O. On account of its low coefficient of expansion, calculated on the basis of the constants of Winkelmann and Schott as equal to $154.5.10^{-7}$, such a glass can be immediately welded to such metals as molybdenum. As our work was to be of a practical character, we selected intentionally a composition of glass used in manufacturing, only employing chemically pure components for the composition of the batch and carrying out the melting in a platinum crucible in an electric furnace, in order to eliminate a set of influences that occur in the manufacturing, but have no immediate relation to our problem.

II.

The batch to be melted was composed of quartz, soda and boric acid. The quartz used was ground and sieved through a sieve 3000 mesh/cm.^{2}, the soda "pure for analysis" from Kalbaum and the boric acid "chemically pure" from our Trust "Goslaborsnabjenié." The batch was prepared once for all the meltings and preserved in a jar with a fitting-in glass cover. When all the constituents had been weighed out, the batch was mixed first with a spatula on a table, then removed into a porcelain ball-mill with porcelain globules and there submitted to further mixing and grinding for several hours.

The composition of the batch was calculated on the basis of the proposed composition of the glass and of the materials used for the melting. As the latter could be considered as pure and containing 100%, the composition of the batch was formed as follows:

Quartz	65.00 parts
Soda	17.10 parts
Boric acid	14.28 parts

The melting was carried out in a tubular electric furnace from the Institute of Metals in Leningrad. This furnace is designed for a heating to 1250°C. The length of the tube is 300 mm., its diameter 60 mm. The batch in a quantity of 3 to 3.5 grams was put into a platinum crucible and this was placed into the furnace, half-length of the tube, which was mounted horizontally and closed on both ends with covers having small openings. The crucible had a platinum cover, but it was not tightly closed, so as to allow a free exit of the gases during the melting process. A platinum-rhodium thermocouple enclosed in a porcelain tube was adjusted above the crucible. The stripped joint of the thermocouple was placed just above the crucible, as shown in Fig. 1. When the crucible had been adjusted in the furnace, the current was turned on and with a gradual removing of the rheostat, the temperature of the furnace rose to the necessary point and was held constant for an hour, after which the current was turned off and the furnace allowed to cool. The cooled crucible was weighed and the loss in weight of the batch during the melting process was thus determined.

Eight meltings were carried out in the above manner, and the maximum temperatures to which the furnace was heated with the crucible adjusted in it and the temperature held constant for an hour, were respectively 500, 600, 700, 800, 900, 1000, 1100 and 1200°C.

Each of the eight samples thus obtained was taken out of the crucible (its loss in weight during the melting process having been determined) and reduced to powder in a mortar of agate, as it is generally done with any silicate designed for analysis.

The powder thus prepared was first treated with tepid distilled water for several hours. This made the undecomposed soda and boric acid as well as the newly formed (during the melting) silicates and borosilicates pass into solution, whilst the insoluble silicates and quartz remained in the precipitate. This precipitate was filtered, after which operation we obtained a residue on the filter and a solution in the beaker. We shall designate the former as R_1 (residue on the filter) and the latter as S_1 (solution in the beaker). Further operations served to determine the content of CO_2 in S_1 and thus to find the amount of soda that had not dissolved in the batch at the given temperature. For this purpose one-half of the solution S_1 was attacked by a solution of calcium chloride and chlorid ammonium. The second half of the solution S_1 served to determine the content of soluble (in water) silicates and borosilicates formed in the

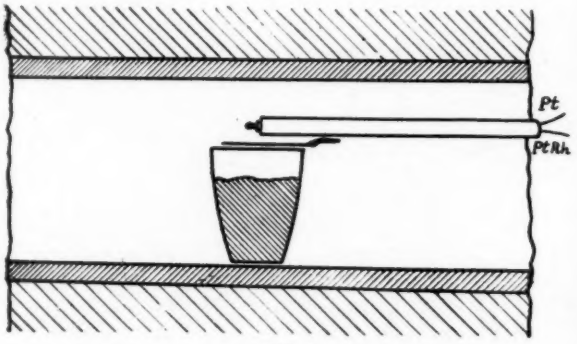


FIG. 1

given melt, for which object the solution S_1 was attacked by hydrochloric acid. By means of reiterated evaporation, drying, filtering and repeated attacks by hydrochloric acid, the content of SiO_2 in the residue was determined. The residue R_1 was also subjected to an attack by hydrochloric acid, and the quantity of SiO_2 extracted in this manner was determined by the usual methods. The results of the above operations for the eight samples are given in Table I.

If we examine the samples as to their appearance, we see that they differ from one another: the earlier members of the series having been subjected to the thermal operation at comparatively low temperatures, present sintered masses, whilst the last sample is nothing else but entirely molten glass, though not quite free from bubbles. With the rise of temperature sintering passes into melting. The fracture of the first members of the set is mat without brilliancy, with big bubbles or small ones. A line drawn with ink on the surface of the fracture of the samples obtained at 500°

TABLE I

Temperature	500°	600°	700°	800°	900°	1000°	1100°	1200°
Appearance of the mass after thermal treatment	Lintered mass with bubbles can be scratched with the nail	Lintered mass with bubbles cannot be scratched with the nail	Lintered dense mass with small pores. Melting begins	Molten mass with bubbles	Molten mass with porcelain-like fracture of potsherd, untransparent	Ditto	Ditto	Transparent melt with separate bubbles
Content of CO_2	None	None	None	None	None	None	None	None
Percentage of "insoluble in water" (relatively to the whole weight)	63.70	63.88	71.25	84.80	92.78	94.70	95.48	95.92
Percentage of "insoluble in HCl" in residue R_1 after treatment with water	98.98	98.30	84.76	75.11	67.36	66.88	66.31	64.13
Percentage of "soluble in HCl" in residue R_1 after treatment with water (computed from difference)	1.02	1.70	15.24	24.89	32.64	33.18	33.69	35.87
Percentage of "insoluble in HCl" in solution resulting from treatment of the whole melt (relatively to the whole weight)	0.07	0.97	1.72	0.86	0.57	1.65	0.67	0.25
Percentage loss in weight of the batch during melting	20.09	20.27	19.34	19.54	20.41	20.37	20.39	20.43

and 600° is imbibed by the substance more or less quickly. With the samples obtained at 700°, 800° and more the fractures does not absorb the ink line. It is evident that the porosity observed in the samples at 500° and 600° differs from the porosity revealed in the samples at 700° and 800°. The pores of the latter are isolated from one another like separate bubbles in the melt, whilst in the former they are united through capillary passages. The vacua of the samples at 700° and 800° can be considered as a gradual transition from the open pores characteristic of the melts at low temperatures to the bubbles characteristic of molten but not yet ready and therefore impure glass. The degree of transparency, in this case depending only on the degree of melting of the samples, gradually increases with the rise of the melting temperature. The earlier samples are entirely untransparent. On the contrary, the sample at 1200° is quite transparent in any layer and vitreous. The samples at 900°-1100° have a porcelain-like fracture of the potsherd and are not "transparent like glass," but "translucid like porcelain."

The strength of the samples also increases from the earlier ones to the last. The sample at 500° can be scratched with the nail, and even easily rubbed off with the finger. The one at 600° cannot be scratched with the nail, but it can be scratched with a steel knife; yet the next sample, obtained at 700°C., resists even steel: the point of a steel knife glides on the surface of the fracture without leaving any mark. The other samples, obtained at higher temperatures, are certainly not less hard than this latter.

We have now to consider the numerical data that characterize the loss in weight of the batch during the melting process. They are given in the last horizontal line of table I. The theoretical loss, calculated on the basis of the composition of the batch, should be equal to 20.86%. In reality, as can be seen in the table, in none of the samples does it surpass 20.43%, dropping to 19.34% in certain cases. The loss in weight smaller than it should be according to theoretical calculation can be explained by the presence of bubbles in the melts. When plotting the theoretical loss we assume that all the gases have left the batch, whilst in reality we find remaining gases in the form of bubbles in all the melts. We cannot admit the presence in the melts of any undecomposed constituents of the batch, for Na_2CO_3 has not been found in any melt, as will be seen from below. Likewise is there no reason for assuming that boric acid may have retained particles of H_2O at the given temperatures. So there is only one supposition available, namely that particles of boric acid and soda gave away their volatile constituents (CO_2 and H_2O), but these did not leave the melts. This last supposition is the most credible as some other investigations[4] show that soluble gases are found—though in small quantities—even in glass entirely molten and free from bubbles.

In the first horizontal line of table I it will be seen that CO_2 has not been detected in any of the melts. Basing on this result, we can say that no Na_2CO_3 was left in any of the samples: soda had had time to decompose, even in the melt at 500°C. Being decomposed, soda reacted with the other components of the batch. Thus, reactions took place already at 500°, though this temperature is considerably lower than the melting temperature of any component of the batch. Boric acid, when heated, lost its water and gradually changed into B_2O_3. At 600° boric oxide melted and changed into a vitreous mass.[5] The melting point of soda is higher. Under usual conditions of pressure it melts at 853°C., when the dissociation of CO_2 becomes observable.[6] Cobb has found that the dissociation of soda begins at 680-690°C. The visible beginning of the reaction of the formation of silicate according to the equation:

$$Na_2CO_3 + SiO_2 = Na_2SiO_3 + CO_2$$

is observed at 800°. At 900° this reaction becomes more intense.[7] Cobb, as mentioned above, studied the conditions of reaction in a batch composed of silica, soda and lime and producing after melting an ordinary lime-soda glass, in which batch the most fusible component was soda. In our

[4] Dralle-Keppeler, "Manufacturing of Glass," v. I, p. I, p. 322, Moscow.
[5] According to Carnelley (in 1878) B_2O_3 melts at 577° ± 5° (Landolt-Börnstein, "Physicalisch-chemische Fabellen," p. 338). According to Hüttner-Fammann (1905) at 853° C.; according to Amadori (1912) at 854° (Landolt-Börnstein, p. 350).
[6] Dralle-Keppeler, "Manufacturing of Glass," v. I, p. I, p. 230, Moscow.
[7] Ibid, p. ?.

conditions, the most easily fused component is boric acid, and we see that already at 500°C. there is no CO_2 left, i.e., there are no traces of soda that has not decomposed. The reaction of the components began at least at 100° below the melting point of the most fusible of them. The dissociation of soda was also completed at 500°C., at much lower temperatures than those observed by Cobb in his batch. The dissociation of water was favored by its reaction with the components of the batch, in the first place, evidently, with boric oxide. The pressure of the vapors of CO_2 when soda decomposes is equal to 1.7 mm. of the mercury column at 660°C.[8] This datum, as can be seen, is very near the datum indicated by Cobb who observed the beginning of decomposition of Na_2CO_3 at 680°-690°C. A certain divergence can be explained by Cobb's data relating to the conditions of a batch in a furnace where the partial pressure may be higher than 1.7 mm. of the mercury column. In our conditions there were no products of combustion of fuel in the furnace and the circulation of air was comparatively free in it, so the partial pressure of CO_2 above the crucible with the batch can be assumed as equal to 0.4 mm. of the mercury column.[9] These data show us that at 600°, in our conditions of partial pressure of CO_2 above the batch, the reaction of dissociation of soda was undoubtedly taking place, and therefore the absence of undecomposed Na_2CO_3 in the melts at 700° and more is entirely justified from this point of view too.

On the basis of all that has been said above, it can be inferred that in the melting process of a batch composed of silica, boric acid and soda the reaction of dissociation of the latter components is completed by 500°C. and at this temperature we find them forming a compound.

Now let us examine the curve of modification of the substances insoluble in water, as shown in diagram I. This curve (1) indicates the amount of silicates insoluble in water and that of silica contained in each melt and having not undergone any reaction. The sharpest rise of this curve

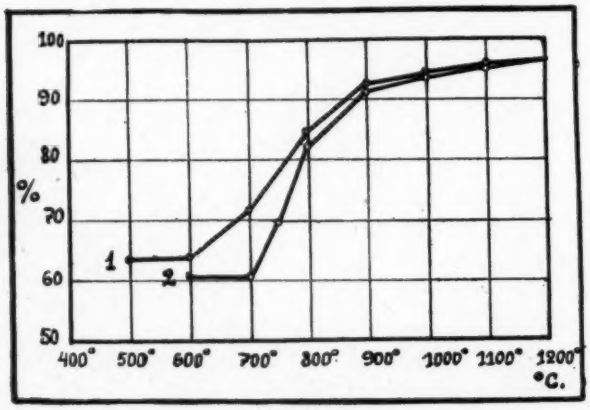


DIAGRAM I

is observed within the interval between 600 and 900°, whilst from 500 to 600° and from 900 to 1200° its ascension is quite insignificant. The fact that the curve does not rise from 500 to 600° indicates that at these temperatures silica does not yet take any part in the reaction, which is confined to the reaction between boric acid and soda. This is also confirmed by the operations with the solution S_1: the content of substances insoluble in HCl is equal to 0.07% of the solution at 500° and to 0.97% at 600°C. These data relate principally to SiO_2, and it is evident that the latter does not yet take any part in the reaction at these temperatures. Again, the curve hardly rises from 900 to 1200° and this proves that the reaction of the formation of silicates has in the main been completed before. In order to precise the temperatures at which this reaction is most intense, "to bring the temperature limits closer together," we had eight more melts of a similar batch carried out. This second series of melts differed from the first in that the melts were not held for an hour at maximum temperatures, but only

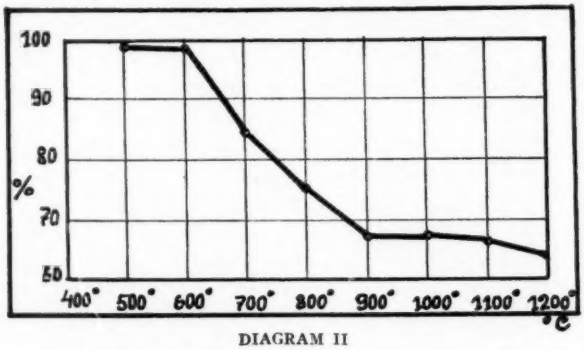


DIAGRAM II

brought to that point and then allowed to cool. The treatment of the melts of the second series was the same as for the first series, but only "insoluble in water" were determined. The curve 2 in diagram I shows the results of the measurements. If we compare it with curve 1, we see that the difference in the quantities of insoluble substances between curve 1 and curve 2 at temperatures from 800° to 1200° is practically none. A great divergence must be noted at 700°C. We observe that in the melt held for an hour at 700°C. the content of insoluble silicates formed is much larger than in the same melt only brought to that temperature and suddenly allowed to cool. At 600°C. no difference is observed for the second series of melts, as to the amount of the "insoluble in water." On the basis of the above data we can say that the reaction of the formation of silicates begins mainly at 700°C. and is practically completed at 900°C. Within the interval between 500° and 700°C. silicates are not being formed yet, as can be seen in the diagram.

The curve in the diagram II, corresponding with the third horizontal line of table I, completes curve 1 of the diagram I and shows the amount of insoluble in HCl silicates and SiO_2 found in the residue R_1 after the solution of the melt. In other words, this curve shows to a certain degree what these remnants are. An attack by hydrochloric acid indicates that primarily, at low temperatures (500 and 600°) they are composed of silica only, as the amount of substances insoluble in HCl reaches 98.98% and 98.30% of the amount of those insoluble in water. After this, the percentage of SiO_2 in the silicates decreases. Silicates are formed in which SiO_2 begins to take a part in reaction with Na_2O and B_2O_3 (below 700° these latter did not enter

[8] Landolt-Börnstein, "Physicalisch-chemische Fabellen," p. 1406.
[9] Assuming that the volume of CO_2 in the air is equal to 0.05%.

into reaction with SiO_2). Thus, curve 3 confirms our preceding considerations. At 1200°C. all the boric acid and soda form a compound with SiO_2. According to theoretical plotting, the total of B_2O_3 and Na_2O is equal to 35%, and the amount of soluble in HCl from the residue R_1 (insoluble in H_2O) is equal to 35.87% (line 4, table I), hence

$$\frac{35.87 \cdot 95.92}{9100} = 35.2\% \text{ of the melt.}$$

If we consider the data obtained through fractional analysis whilst the attack of the melts by hydrochloric acid and water was carried out, we must say that they certainly have no absolute value. In this analysis we made many allowances. When we had to determine the "insoluble in water" in the primary weight of the melt, we admitted that all silicates formed in the melt were to pass into the residue. In reality it is quite different. We know that glasses, even very resistant ones, especially when reduced to powder as we did with our melts, lose their alkaline constituents, if they are submitted to an attack by water. In our case this is confirmed, for instance, by the presence of 0.25% of insoluble in HCl found in the solution resulting from an attack by water of the primary mass of the melt obtained at 1200°C. Thus, it must be admitted that part of the silicates had passed into the water solution and, therefore, we cannot say that after an attack by water we obtain in the residue absolutely all the silicates formed in the melts. Further, we did not determine the content of B_2O_3 in the melts, nor in separate solutions and residues, as the total weight of the melt in the platinum crucible was always about 3 grams, and any quantitative determinations of boric acid in such small does are difficult to carry out, nor do they warrant any precise data.[10]

[10] A. A. Matchienin and T. Korzukhina, "A New Method of Determining Boric Acid in Glasses." Journal of Russian Physical-Chemical Society, vol. LIX, issue 7-8, p. 573-578, 1927.

We are quite sure that an extension of the methods of investigation will give a much more exact idea of the reactions, in the melting process of our soda-borosilicate. In particular, if petrographic analysis were applied to the investigation of our melts, it would enlarge the circle of our knowledge to a considerable degree, as well as the application of fractional analysis accompanied by a quantitative determination of different components in solutions and residues. This latter operation would require, however, larger quantities of melts than we could dispose of at present.

We intend taking up these problems of the chemism of glass-melting later on, with extended methods of investigation, and consider our present paper as a preliminary communication to a series of studies dealing with this most important process.

III.

1. Experiments of melting of a batch of soda-borosilicate glass in a laboratory electric furnace at different temperatures, followed by fractional chemical analysis of the melts, showed that reaction between different components of the batch sets in below 500°C. and is completed on the whole at 900°C.

2. The components which enter into reaction first, are soda and boric acid; they dissociate and at 500°C. form a compound. No traces of undecomposed soda are to be detected in the melt at 500°C.

3. The reaction of the components of the batch begins far below the melting point of the most fusible of them.

4. At 700°C. silica begins to take part in the reaction. The formation of silicates is most intense at 700°-900°C. Below 700°C. apparently no silicates are formed.

5. The temperature interval between 900° and 1200°C. is characterized by a certain quantity of previously formed silicates. Between 1100° and 1200° the melt becomes a vitreous transparent mass.

Society of Glass Technology Broadens Activites

London Section Organized

At the general meeting of the Society of Glass Technology in London on May 15, 1929, a proposal to organize a London section of the Society was discussed and a resolution to do so adopted. The formation of local sections of the Society was first suggested by Professor W. E. S. Turner in a memorandum to the members of the Council of the Society in February, 1927. The new section began its activities on October 2 when its first meeting was held at the offices of Messrs. Holophane, Ltd., Westminster. It was well attended and enthusiastic support was given to the new venture.

Dr. S. English presided and read a letter of good wishes from Mr. Herbert Webb, the president of the Society of Glass Technology. Mr. B. P. Dudding gave a brief account of the inauguration and proposed activities of the London Section.* This was followed by a general discussion on the possible activities of the section. It was suggested that the main object of the meetings should be to provide opportunities for the free discussion of matters of practical interest. It was emphasized that the activities of the section should include, in addition to matters primarily of interest to the glass industry, those of interest to closely allied industries in which glass is an important raw material such as the the manufacture of electric lamps, wireless valves, thermometers, hydrometers, scientific glassware, mirrors, etc. It was the general opinion that meetings of the section should be held in the evening.

A representative Council of the London Section was formed to act as an executive committee and consists of officers of the Society resident in the London district and London members elected at the meeting.

The members of the Council are:

OFFICERS OF THE SOCIETY OF GLASS TECHNOLOGY.

Messrs. F. F. S. Bryson, E. A. Coad-Pryor, J. D. Cauwood, B. P. Dudding, Dr. S. English, Col. S. C. Haise, Messrs. Edward Meigh, Vaughan H. Stott and W. W. Warren.

ELECTED LONDON MEMBERS.

Messrs. D. H Baird, T. O. Blake, E. J. C. Bowmaker, D. Dixon, A. H. Hecker, G. Lovell, A. L. Marden, J. B. Murgatroyd, F. G. Orme and C. Saxton.

The meeting elected Mr. Verney Stott, of the National Physical Laboratory, Teddington, Middlesex, as honorary secretary of the section. The next meeting of the section was fixed for 7:30 p. m. on Wednesday, November 6th, at the Osram G. E. C. Glass Works, North Wembley.

At the conclusion of the above business a number of experimental demonstrations were given.

Prof. W. E. S. Turner, the honorary secretary of the Society of Glass Technology, with characteristic enthusiasm for the affairs of the society, had come up from Sheffield to attend the meeting and after the demonstrations he gave reminiscences of the formation of the parent society and expressed his good wishes for the success of the London Section.

The meeting concluded with a vote of thanks to those who had taken part in the preliminary work of forming the London Section.

*See *Jour. Soc. Glass Tech.*, June, 1929. Proceedings page 55.

On The Absorption of Light *in colored glass*

A paper by
R. ZSIGMONDY *
Translated by
S. R. SCHOLES †

CHARACTERISTIC absorption spectra of commercial colored glasses have often been described. We find, for example, the absorption spectra of the blue cobalt glass, of the red copper glass, etc., described and portrayed in Vogel's Spectro-Analysis of Iridescent Substances (Vogel's Spectro-Analysis of Iridescent Substances, Berlin, 1889). It is known among glass workers that the color of a glass depends not only upon the nature of the colored oxides, but also in a high degree upon the composition of the glass itself, and often, in many cases, on the working of the glass, so it is possible to obtain with copper oxide blue and green glasses; with nickel oxide yellow and also violet, according to the composition of the glass batch with which the colored oxide is melted. One can also prepare from an ordinary chrome-bearing glass batch, dark green, yellowish green and opaque. Here the working of the molten glass is in a large measure responsible for the color in the finished glass.

It is evident from these examples that the description of the absorption spectra of a colored glass, without consideration of the composition and working of the glass, is of value only in single and defined cases.

An earlier investigation of Eder and Valenta (Sitzungsber. d. k. Akad d. Wissensch. zu Wien 1884) (Eder and Valenta berucksichtigen die qualitative and quantitative Zusammensatzung der Glaser), concerned itself with a photographic determination of the ultraviolet and visible absorption spectra of colorless and colored glasses.

In the present investigation, which was carried on under the direction of Mr. D. O. Schott in the laboratory of the Jena Glass Works, a true as possible picture of the light absorption of colored glasses of known composition, obtained by means of spectrophotometric measurements, will be given.

* *Annalen der Physik und Chemie*, (4) 4, 60, 1901.
† Technical Director, Fostoria Glass Company, Moundsville, W. Va.

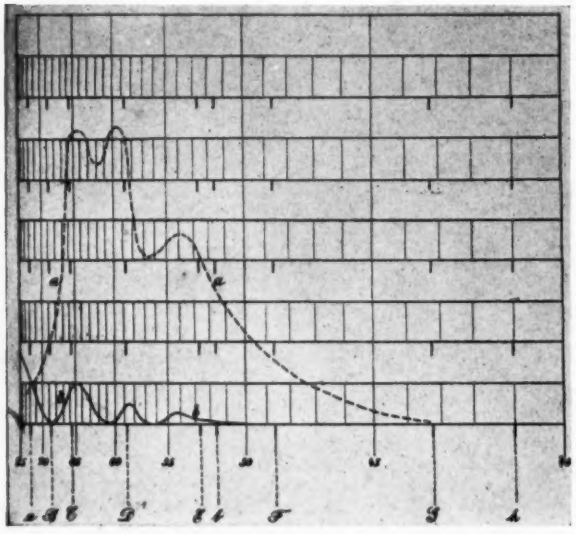


FIG. 1

a. Absorption Spectrum of Cobalt Glass determined by the Spectrophotometer.
b. Absorption Spectrum of Colbalt Glass determined with a Spectroscope.

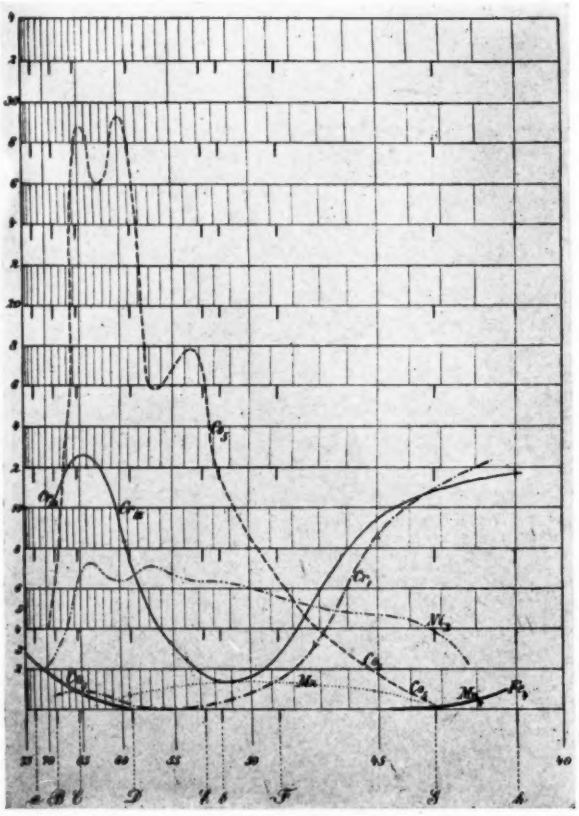


FIG. 2

COMPOSITION OF THE GLASS TYPES

No.	In Equivalents	In Percentage						
		SiO_2	Na_2O	K_2O	CaO	ZnO	PbO	B_2O_3
1	Na_2O. $3SiO_2$	74.5	25.4	....	....	....	....	....
2	K_2O. $3SiO_2$	65.7	....	34.3	....	....	....	....
3	Na_2O. CaO. $5SiO_2$	71.8	14.8	....	13.4	....	....	....
4	K_2O, CaO, $5SiO_2$	66.7	....	20.9	12.4	....	....	....
5	Na_2O, PbO, $5SiO_2$	51.4	10.6	....	....	....	38.0	....
6	K_2O PbO. $5SiO_2$	48.7	....	15.2	....	....	36.0	....
7	Na_2O, ZnO, $5SiO_2$	67.6	13.9	....	....	18.25	....	....
9	$Na_2B_4O_7$	....	30.7	....	....	....	....	69.3
11	B_2O_3	....	....	....	....	....	....	100.0
15	Lead Silicate	20.0	....	....	....	....	80.0	....

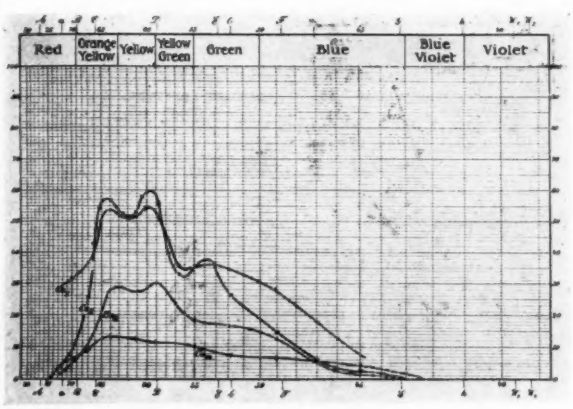


FIG. 3

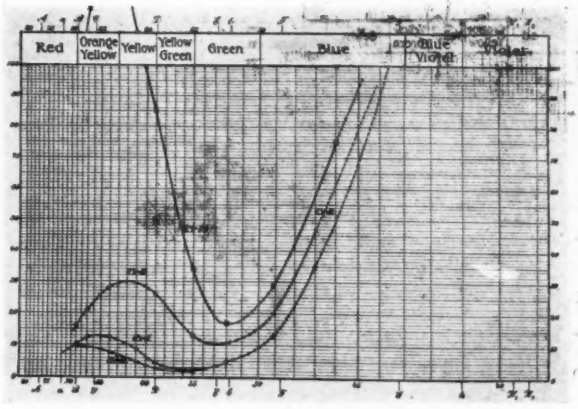


FIG. 4

Glasses of definite types whose compositions correspond to the data given in the following table were melted in an oxidizing flame, together with determined amounts of colored oxides. The extinction coefficients of these glasses were measured with a Glan spectrophotometer, and after reduction to a comparable basis, were completed in curves.

Besides the glasses shown in the table, there were two others included in the investigation, a sodium borosilicate No. 12 and a barium borosilicate No. 14.

To the batch of the glasses given in the above table was added a solution of the nitrates of the colored oxides[1] in such an amount that 100 grams of the colorless glass contained the following amounts of colored oxides:

Chromium oxide	1 gram
Copper oxide	2 grams
Cobalt oxide	1/10 gram
Nickel oxide	25/100 gram
Manganese oxide	1 gram
Iron oxide	2 grams
Uranium oxide	2 grams

As a short designation of the above colored glass, I used the chemical formula of the coloring metals and placed the number of the type of glass with which the colored oxide was molten as a subscript thus:

Cu_3 denotes a glass which in 102 grams contained 2 grams of copper oxide, 71.8 grams of silica, 14.8 grams sodium oxide, 3.4 grams calcium oxide, etc. The working of the glass was the same in all cases and I will describe it presently in the case of cobalt glass. With the aid of the Glan photometer, the extinction coefficient was determined at different places on the spectrum. The Bunsen extinction coefficient was employed as a convenience. (Bunsen & Roscoe, Pogg. Ann. 101. p. 238. 1857.) Define the extinction coefficient as the reciprocal value of that thickness of a layer which the substance must have in order that the light which passes through shall be weakened, by absorption, to 1/10 the intensity of the light falling upon it. If the coefficient is denoted by E, we have the following:

$$E = \frac{-\log J}{d}$$

where J is the intensity of the light which passes through d, the thickness of the absorbing glass, and the intensity of the light source is taken as equal to one. Since, in considering equal quantities of solution the extinction coefficient is proportional to the concentration of the dye stuff.

[1] In the chromium glasses pure chromic acid solution was used.

Cobalt Glasses

Cobalt was added to the glass batch in such a quantity that 100.1 grams of finished glass contained 0.1 grams of CoO. The working of the cobalt glasses was the same as that of the above glass; they were melted in an oxidizing fire, stirred in the molten condition to remove the cords, then poured in molds, and after the slow cooling, cut into plates. The plates were cut and polished and then investigated with the spectrophotometer. Absorption power of the silicate glass, Co_5, Co_7, the borax glass, Co_9, I set forth in Fig. 3. Between the curves for Co_5 and Co_7 lies that of Co_4; the last is not drawn in. With the help of the comparison spectroscope, the glass Co_1 and Co_3 were compared with the above when it was apparent that the spectrum of Co_3 corresponds with that of Co_7, and that of Co_1 with that of Co_5.

Of interest is the close agreement in absorption of the cobalt glasses of the type R_2O, RO and $5SiO_2$.

Much closer, indeed quite similar, is the absorption of the borax glass Co_9; quite varying from the same is that of the borosilicate glass Co_{14} (pure boric oxide is only slightly colored rose-red by cobalt oxide).

In order to show how much the pictorial description of the absorption spectra, after observation with the comparison spectroscope, differs from the description of the magnitude of the absorption, the absorption of the glass Co_5 and the pictorial of the absorption spectrum of the cobalt glass according to H. W. Vogel, are drawn in the same scale in Fig. 1.

Chromium Glasses

Chromium glasses were melted with the addition of enough chemically pure chromic acid dissolved in water that the final glass contained 0.99% Cr_2O_3 under the assumption that the chromic acid was completely reduced in the glass to chromic oxide. (This assumption was made in order to have a definite rule for calculating the amount of chromium in the glass.) It was, however, not entirely in agreement with the facts as Linke and Adam have shown. They obtained a greenish white glass when fused with Cr_2O_3, but by mixing $K_2Cr.O_4$ a greenish yellow glass was obtained.

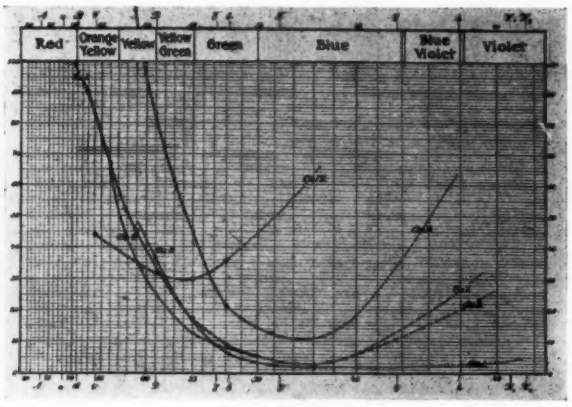


FIG. 5

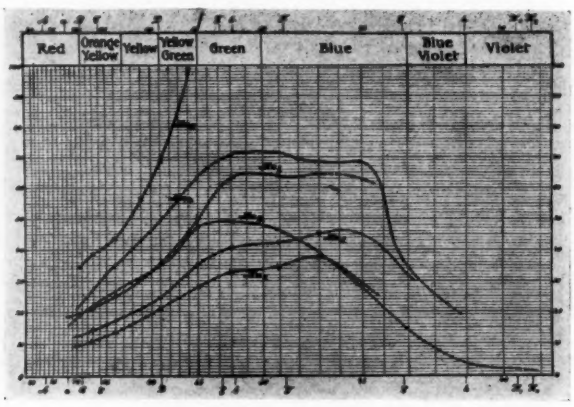


FIG. 7

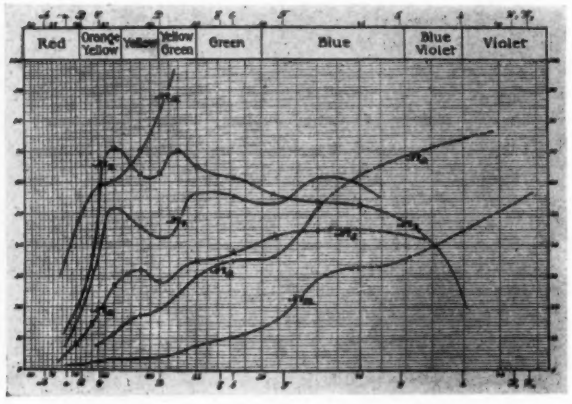


FIG. 6

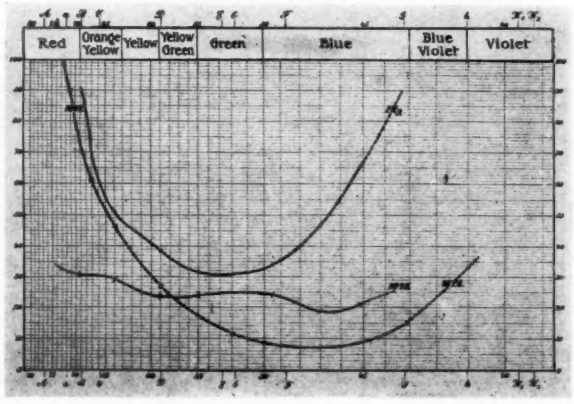


FIG. 8

The pure chromium silicate glasses Cr_1, Cr_3, Cr_6, Cr_7 show good agreement in their absorption in the blue part of the spectrum. The rising branch of the curve in the blue coincides in the glasses Cr. and Cr_6 and also in the glasses Cr_3 and Cr_9. In the red part they show great differences. On account of the aforementioned variation in the color with the chromium glasses, I have omitted the other curves.

Copper Oxide Glasses

The copper silicate glasses show good agreement in the course of the curve. I show in Fig. 5 the absorption curves for Cu_1, Cu_4, Cu_7.

These glasses even in thick layers transmit the blue part of the spectrum almost entirely and the glass Cu_1 also the violet. Far different is the absorption of the borax glass Cu_9 and also the borosilicate Cu_{12}.

The curves as shown represent the absorption as obtained by measurement of a glass with about 2 per cent CuO. If one increases the copper oxide to three or four times this value, green glasses are obtained of far different absorption.

Nickel Glasses

The nickel glasses show a much greater variety in their coloring than any of those mentioned before. Even the silicate glasses show differences of absorption among themselves. The only ones which show anything like agreement are the glasses Ni_1, Ni_3, Ni_5, whose absorption curves differ only a little bit from the curve Ni_3 as shown in Fig. 6.

It is known that sodium glasses colored with nickel are reddish brown or reddish violet, but that the potassium glasses are violet. As would be expected then, the absorption curve of Ni_2 and Ni_4 is different from the sodium glasses. The curve Ni_2 shows great similarity to that of the cobalt silicates, but differs from them in a different position of the maxima.

The entirely different form of the curves of the brown nickel borax glass Ni_9 and the yellow glass Ni_{12} deserves notice. In Fig. 6 is also shown the curves of the heavy lead silicate Ni_{15}.

Manganese Glasses

The coloring which glasses take on with the addition of manganese are also of importance, because manganese peroxide in the form pyrolusite has long been used for decoloring the greenish glass. If pure pyrolusite is added to a colorless glass, it will color a potassium glass violet and a sodium glass more of a reddish violet. These colors are in measurable mixtures of all colors of the spectrum, of which the green is absorbed the most, as will be seen from a glance at the curves in Fig. 7. It is well known in the glass industry that the addition of pyrolusite as a coloring and also as a decolorizing agent is accompanied with great uncertainty. This uncertainty is not so much dependent upon the presence of impurities in the pyrolusite as it is upon its behavior in solu-

tion, being reduced in the melt to colorless manganous compound. Reduction materials are present in a great many batches and also in the furnace the flame is strongly reducing. In order to prevent as much as possible this reduction, my glass was treated with manganese nitrate or with manganese peroxide in such amounts that in 100 grams of glass one gram of Mn_2O_3 was present and the flame was so regulated during melting that reducing action from it was prevented. The conditions were such that the highest state of oxidation should be stable, but in spite of this, large proportions of the manganese peroxide went over into manganous compounds, which are colored very little if at all. I was able to make a quantitative determination in the case of the borax glasses by dissolving the glass in boiling hydrochloric acid and determining the chlorine.

The more the acid part of a glass exceeded the basic, the more oxygen was lost with formation of a lower oxidation product of manganese. In the cases of very acid composition, the higher oxides went completely over into manganous oxide with liberation of oxygen. This liberation of oxygen took place whether manganese nitrate or manganese peroxide was used. In glasses with considerable alkali content, such as borax, by far the greater part of oxygen was displaced (90 to 95%), but a small residue remained with the manganous oxide or held in chemical combination in the glass. Such glasses are more or less intensively colored.

Which oxide of manganese is responsible for the color of the glass could not be proved. It may be the peroxide MnO_2, Mn_2O_3, Mn_3O_4 or another oxide which is as yet unknown.

Of importance appears also the condition that at first a large part of the peroxide dissolved in the glass as the colorless MnO and that the coloring power of the added manganese does not make up to its quantitative value. This condition explains in part the well known uncertainty of manganese coloring. From examination of the curves, it might be conjectured that two different coloring compounds of manganese are present, one of which predominates in sodium glasses, the other in potassium glasses.

In Fig. 7 are only a few of the measured curves. The curve of Mn_5 coincides almost exactly with that of Mn_3. Mn_7 runs about the same as Mn_3, but lies a little bit lower. The course of the curve Mn_6 resembles that of Mn_4. The absorption of the first glasses, however is only one-half as great as that of the latter ones.

We notice also if we compare the two water glasses Mn_1 and Mn_2 a correspondence with the absorption of the potash glasses Mn_4 and Mn_6 on the one hand and a differing from them in agreement with the absorption of sodium glasses Mn_3, Mn_5, Mn_7 on the other.

Iron Oxide Glasses

The colors which may be obtained by the addition of iron oxide to the glass are unusually numerous. The three oxides Fe_2O_3, Fe_3O_4 and FeO may exist either alone or in the presence of one another or in combination with silica or boric acid as well as double salts or partially in combination with alkalies, and in addition it is also possible that the iron may be present in a metal dissolved in the glass.

Each combination of iron will, at least, be accompanied with a characteristic color. It is possible to obtain with iron in one and the same glass the most diverse colors. Yellow, yellow green, green or bluish green glasses may be obtained. It will, therefore, be no object to determine by numerous measurements the great number of curves and I show here in Fig. 8 as an example the absorption of the yellow green glass Fe_3 and glass of similar composition No. 1072 (2% with 2% Fe_2O_3) and the same glass after having added to the molten glass 1% MnO_2 for the purpose of decolorizing (Curve 1075). It is plain in the two last mentioned glasses that they dissolve pyrolusite not only as a complementary color, increasing the absorption in the blue-green, but also reduce the absorption in the red part of the spectrum, an effect which is explained by the oxidation of some of the ferrous oxide which is present.

In glasses I would like to call attention to the great difference in coloring power of several oxides. In order to make possible comparisons, I have in Fig. 2 plotted the absorption A of the glasses CO_5, Cr_{12}, Ni_2, Cu_1, Mn_4 and Fe_4.

On examination of these curves, it is easy to see that with the presence of equal amount of coloring oxides in a unit volume of glass, the cobalt oxide would act as a stronger coloring material than the other oxides and that iron oxide possesses a very light coloring power. A condition which is of the highest importance, considering the wide distribution of these substances in nature.

News Letter from Germany

Rationalization is slowly but steadily making progress in the German glass factories, mainly through the introduction of Fourcault machines. There are several manufacturers in various sections of Germany who have modernized their plants in this manner, thereby reducing the number of productive laborers by approximately 75 per cent and at the same time obtaining better, lighter and saner working conditions, be it through the elimination of infection through the pipe or be it through lessening the dangers of damaging the eyes, etc.

* * *

Some figures might be helpful to illustrate the actual increase in the capacity of the modernized German glass factories. A manufacturer who had a daily production of about 3,000 square feet has been able to increase the same with the use of Fourcault machines to over 4,500 square feet. The important thing, however, is that at the same time the number of working people could from 68 be reduced to 44, which is equivalent to 35 per cent, while production has been raised by 50 per cent. In former years it was not possible to manufacture glass plates beyond a size of 21 square feet and a thickness of 2.16 inches. Today the maximum size is about 65 square feet and the thickness approximately 3.15 inches.

* * *

In view of the low buying power of the German people at large, and in view of the necessity to create an export surplus out of which to pay the various obligations resulting from the loss of the war, as well as taxes, etc., the German glass manufacturers are making great efforts to increase their export business. Roumania has been found an excellent market for crystal- and semi-crystal ware which is not manufactured by any Roumanian factory, inasmuch as none of them specializes in this particular field. The bulk of this merchandise comes from Germany and Czecho-Slovakia. Ordinary bottles form another important import article, and they are mainly brought from the latter country. In glass vases it is Germany, however, which takes most of this business. Another field in which the German industry appears very strong is medical and photographic glassware of different style and quality and for various purposes; there is also mirror and ornamental glass which form no small part of the German import business.

The Manufacture of Wire Glass

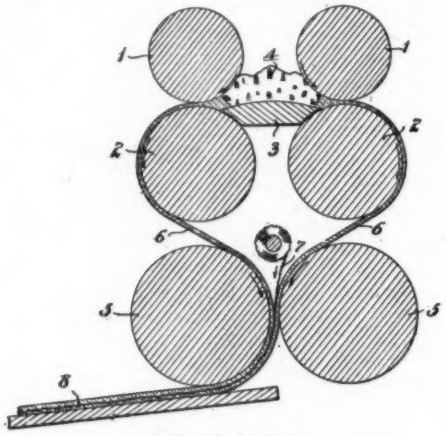
as exemplified by patented inventions

by JOSEPH ROSSMAN
Patent Examiner, U. S. Patent Office

(Concluded from the October issue)

84. Hoyer, 959,537, May 31, 1910.

The method consists in dumping a mass of molten glass into a fixed stationary support or table, rolling the mass of glass in opposite directions to form two independent layers of glass, combining the layers together with pressure to form



PAT. NO. 959,537

a single finished sheet of glass, and interposing a piece of wire mesh or fabric between the two layers of glass at the time they are combined.

87. Butler, 980,063, December 27, 1910.

The method consists in breaking down a batch of molten glass and embedding the metallic reinforcement by means of a roller and then passing a second roller back and forth over the soft glass in order to remove the seams.

88. Jungers, 1,062,013, May 20, 1913.

The method consists in rolling out a single thick sheet, progressively, but in sequence to the spreading of the sheet, insetting a sheet of wire netting through one side of the sheet and disposing it in a substantially undeviating plane remote from, and parallel with, the surfaces of the sheet, concurrently and progressively pressing the wire inset sheet between forming surfaces accurately parallel with each other, spaced and maintained apart a distance just equal to the mean thickness of the pre-formed sheet and thereby restoring the integrity of that side of the sheet through which the wire is inset, and continuing the operation progressively until the sheet is formed.

89. Ehret, 1,113,208, October 13, 1914.

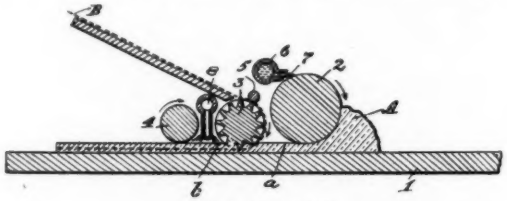
The method consists in mechanically embedding wire between layers of glass and passing electric current in series through the wire and the layers of glass.

91. Franzen, 1,135,937, April 13, 1915.

The method consists in, first, spreading a batch of molten glass to layer form with protrusions upon its surface, second, while maintaining such protrusions free from chilling contact with any instrumentality, sinking a web of wire through such protrusions by pressure localized and concentrated upon the web at intervals corresponding to the intervals between the successive protrusions, and, third surfacing the layer.

90. Franzen, 1,135,371, April 13, 1915.

The method consists in spreading a batch of molten glass to layer form, sinking wire into one surface of the layer so



PAT. NO. 1,135,371

spread, maintaining a non-oxidizing atmosphere over that surface into which the wire has been sunk, and smoothing the surface.

92. Cox and Shuman, A., 1,156,214, October 12, 1915.

A corrugated sheet of glass in which each surface presents a continuous curve and repeatedly crosses the median plane of the sheet and having inclosed in it a corrugated sheet of wire netting.

93. Byrnes, 1,141,932, June 8, 1915.

The method of drawing wire glass, consists in simultaneously drawing two sheets or plates of glass upwardly from a glass bath, drawing a wire fabric between them, pressing the two sheets together to embed the fabric, and then fire-polishing the wire glass during the upward drawing of the structure.

94. Lea, 1,187,346, June 13, 1916.

A pane of glass, comprising a sheet of glass consisting of inner and outer layers and a wire netting therebetween having its members covered with a fluffy loose asbestos, the netting and its covering being embedded in the sheet of glass the inner layer having a roughened surface.

95. Fullerton, 1,197,474, September 5, 1916.

In the manufacture of reinforced glass, a sheet of glass and a reinforcement therein, reinforcement comprising a plurality of metallic patterns, assembled in the most convenient form, the patterns being fastened together with units of less tensile strength than the patterns.

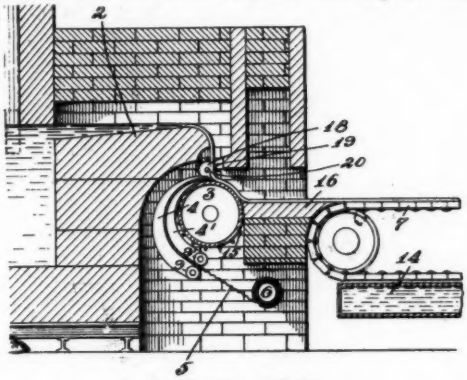
96. Franzen, 1,199,365, September 26, 1916.

The process of manufacturing wire glass consists in forming a ball or batch of molten glass into a smooth flat sheet having a ridge or wave on its surface at the head end of the sheet, introducing a wire fabric into the glass sheet through the upper surface thereof, and pushing the wave or ridge

on the surface of the sheet progressively forward over the part containing the wire fabric, so as to close up and smooth out the irregularities upon the surface of the glass caused by forcing the fabric into the sheet.

97. McCoy, 1,217,614, February 27, 1917.

The method consists in flowing a sheet of glass from a molten mass by the pressure of the mass, introducing a moving trellis into the path of the flow, maintaining the cross section of the trellis in concave convex formation during its initial application to the glass, reducing the cross sec-



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tion from the concave convex formation into a plane formation by subjecting the trellis to a tension away from the medial line of, and toward the edges thereof, during its contact with the glass, allowing the tension to relax after its contact with the glass and simultaneously applying a cooling medium thereto.

98. Richeter, 1,241,767, October 2, 1917.

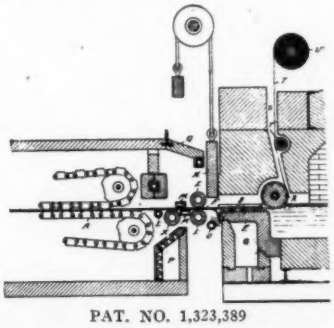
The method for making ornamental glass sheets consists in securing a plurality of small metal plates to a wire mesh and spaced and positioned in respect to each other in accordance with a predetermined pattern and entirely embedding the wire mesh and plates within a sheet of glass.

99. Pease, 1,259,772, March 19, 1918.

The process consists in drawing the glass in hollow cylindrical form surrounding the wire, then pressing the sides of the cylinder together with the wire between and then in annealing the sheet out of contact with the atmosphere.

100. Colburn, 1,323,389, December 2, 1919.

The method of drawing wire glass consists in guiding the wire cloth into the mass of molten glass, drawing the



PAT. NO. 1,323,389

molten glass in sheet form, horizontally, parallel with the surface, with the wire cloth embedded therein.

101. Shuman, V., 1,355,625, October 12, 1920.

A fire resisting body, comprising a sheet of wire glass, a sheet of plate glass, and an interposed layer of organic mataerial between them.

102. Shuman, A., 1,397,149, November 15, 1921.

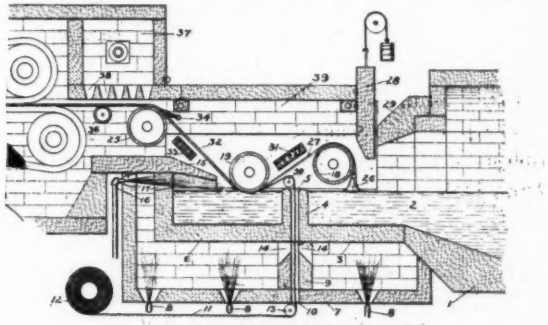
The method of making corrugated wire glass consists in rolling a crimped sheet of wire into a corrugated sheet of glass, centering the wire mesh in the hot corrugated sheet by operating through the surface of the sheet, and repeatedly patting the surface of the corrugations while hot.

103. Cox and Shuman, A., 1,418,236, May 30, 1922.

The method of making corrugated wire glass consists in rolling a flat sheet of wire glass with mesh having twists adapted to tighten to increase the distance between them, and while the sheet retains some of its initial heat, corrugating the sheet and tightening the twists.

104. Bowley, 1,425,218, August 8, 1922.

The method of drawing wire glass, wherein a continuous sheet of glass is drawn from a mass of molten glass, one face of the sheet being maintained cool, whereas the other

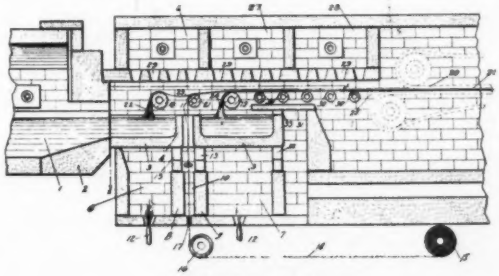


PAT. NO. 1,425,218

face is heated and dipped along with a contacting sheet of wire mesh, into a molten bath of glass, wherein the sheet and wire are united, and a new sheet surface formed covering the wire mesh.

105. Crowley, 1,489,822, April 8, 1924.

The method of making wire glass by separately drawing upwardly and then horizontally, the upper half of the sheet, the wire mesh, and the lower half of the sheet, and



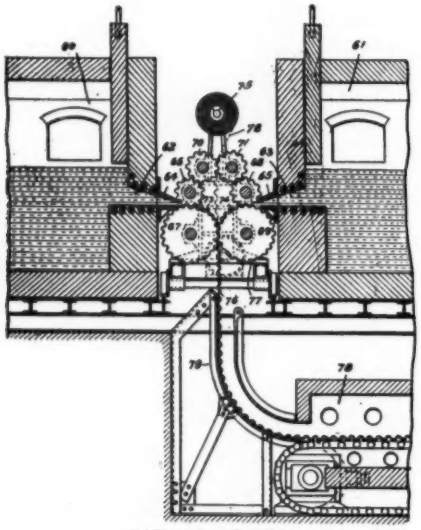
PAT. NO. 1,489,822

then bringing these parts into contact and uniting them to form a single sheet after each has been independently deflected into the horizontal plane.

106. Fox, 1,541,635, June 9, 1925.

A process of making wire glass which consists in continuously flowing two ribbons of glass so that they converge and meet, corrugating the sheets during such movement, con-

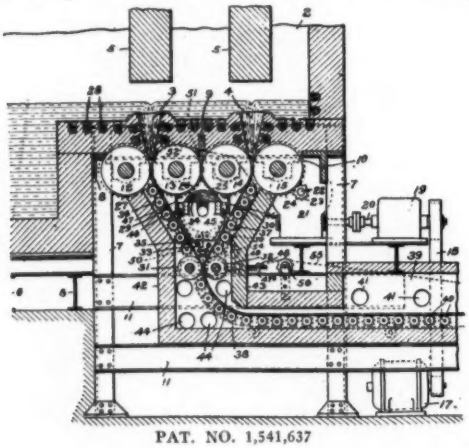
tinuously corrugating a wire mesh, feeding it between the two ribbons as they meet and applying pressure to the outer faces of the ribbons to cause them to weld.



PAT. NO. 1,541,635

107. Gelstharp, 1,541,637, June 9, 1925.

The process contemplates the continuous flowing of two ribbons of glass from sources of supply, so that they converge, feeding a wire mesh between the two ribbons, apply-



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ing pressure to the outer faces of the ribbons to weld them together with the wire mesh therebetween, and then carrying the glass ahead through a leer where it is flattened and annealed.

108. Cox and Shuman, A., 1,585,607, May 18, 1926.

The process of making corrugated wire glass consists in rolling a flat sheet of glass with flat wire mesh embedded therein and while the interior portion of the sheet is sufficiently plastic by heat to permit the twists of the mesh to stretch and while the exterior of the sheet is sufficiently solid by cooling upon bending to retain its form, corrugating the sheet and mesh at one operation.

109. Shuman, A., 1,592,228, July 13, 1926.

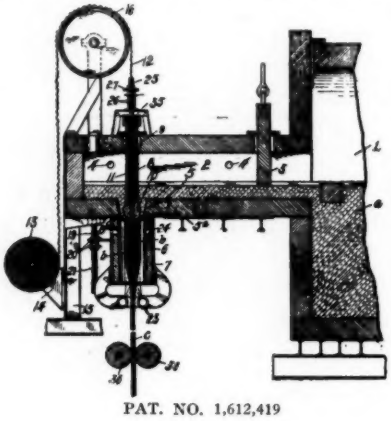
The process of the invention consists in rolling a flat sheet of glass with flat wire mesh embedded therein, and, while the interior portion of the sheet is sufficiently plastic by heat to permit twists of the mesh to stretch and while the exterior of the sheet is sufficiently solid by cooling upon bending to retain its form, simultaneously corrugating the sheet and mesh in part by laying it on a corrugated table and in part by pressing it between corrugated surfaces.

110. Byrnes, 1,597,953, August 31, 1926.

In the manufacture of wire glass, the steps consisting of continuously directly a plurality of sheets upwardly in a general vertical direction from a bath of glass, bending the sheets into another direction at the place where one of the sheets first changes its general vertical direction, and continuously embedding the wire mesh between the sheets at the place.

111. Danner, 1,612,419, December 28, 1926.

The method of forming re-enforced sheet glass consists in flowing molten glass down opposite sides of a directing member in the presence of heat, merging the glass at the

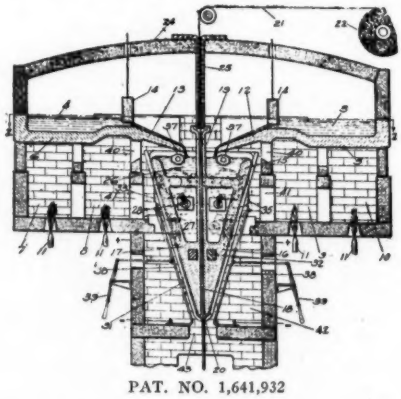


PAT. NO. 1,612,419

discharge end of the member and flowing it therefrom in single sheet form, and passing a re-enforcing means through the member and introducing it into the forming sheet between the merging portions thereof.

112. Reece, 1,641,932, September 6, 1927.

The method consists in drawing a sheet of wire mesh downwardly, and flowing a stream of molten glass evenly



PAT. NO. 1,641,932

and continuously from a pool of molten glass onto each face of the wire mesh, the exposed surface of each stream flowing from the exposed surface of the pool without touching any

solid bodies till after it has formed an outer surface of the glass sheet.

113. Bull, 1,632,363, June 14, 1927.

A laminated glass product composed of sheets of glass held together by a transparent membrane and one of the sheets containing therein spaced strands of disconnected wires in non-crossing relation.

114. Liptak, 1,646,097, October 18, 1927.

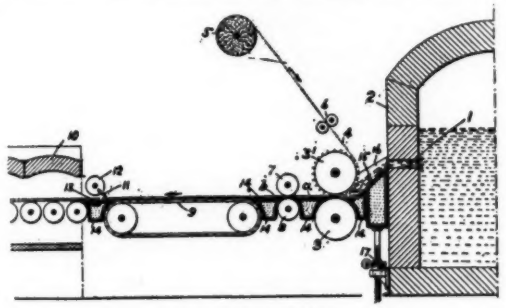
Glass having alternate re-enforced and unre-enforced areas arranged to permit the severance therefrom of smaller sections of varying size, so that each section may have an intermediately disposed unre-enforced area flanked by re-enforced areas.

115. Franzen, 1,668,200, May 1, 1928.

The method of forming sheet glass consists in passing molten glass through a forming and working mechanism presenting to the glass a series of openings to produce a sheet of one thickness and moving simultaneously the forming and working mechanism to present openings of another thickness while the glass is being passed through the forming and working and mechanism.

116. Cox and Shuman, A., 1,676,772, July 10, 1928.

The process consists in simultaneously and continuously feeding wire mesh or netting and flowing a stream of molten glass from a glass tank on the netting or mesh, contin-



PAT. NO. 1,676,772

uously embedding mesh into the stream to associate the mesh and stream in rough sheet form, and pressing the moving rough sheet to smooth it.

118. Jordan, 1,677,095, July 10, 1928.

A method for constructing wire reinforced polished glass, consisting in causing the flow of molten glass and in shaping the glass into sheets at two equi-distantly spaced points, converging the molten sheets to a fusing point, feeding and directing a sheet of wire fabric between the sheets of molten glass at their fusing point, and injecting air under pressure upon the surface of the molten glass as it feeds and shapes into sheets.

119. Clark, 1,708,662, April 9, 1929.

The method consists in drawing a sheet of wire fabric through a bath of molten glass, protecting the fabric from contact with the glass in starting the draw, and removing the protective means from the body of the sheet of fabric when it is desired to start the draw while still protecting the edge portions of the fabric from contact with the glass.

U. S. Patents Granted for Machines Making Wire Glass

F. Shuman	No. 483,020	September 20, 1892
F. Shuman	510,716	December 12, 1893
F. Shuman	510,823	December 12, 1893
Overn	516,221	March 13, 1894
Ryon	531,570	December 25, 1894
Gregg & Stouffer	534,391	February 19, 1895
Tondeur	538,393	April 30, 1895
F. Shuman	546,196	September 10, 1895
Weber	555,351	February 25, 1896
F. Shuman	561,920	June 9, 1896
F. Shuman	574,458	January 5, 1895
Hartung	610,586	September 13, 1898
Sheppard	649,647	May 15, 1900
Sheppard	653,850	July 13, 1900
Locke	656,296	August 21, 1900
Hartung	681,786	September 3, 1901
Cunliffe & Taylor	766,429	August 2, 1904
Schmertz	791,216	May 30, 1905
Schmertz	791,217	May 30, 1905
Tondeur	792,803	June 20, 1905
Baldwin	800,131	September 20, 1905
Baldwin	800,132	September 20, 1905
White	805,608	November 28, 1905
Meyer	805,657	November 28, 1905
Morenus	805,659	November 28, 1905
Walsh	810,446	January 23, 1906
Walsh	810,447	January 23, 1906
Meyer	810,786	January 23, 1906
Heidenkamp	812,994	February 20, 1906
Buttler	814,515	March 6, 1900
Franzen	822,357	June 5, 1906
Davies	827,427	July 31, 1906
Davies	827,686	July 31, 1906
Furcalt	837,265	November 27, 1906
Franzen	839,575	December 25, 1906
Baldwin	843,860	February 12, 1907
Baldwin	846,771	March 12, 1907
Baldwin	847,878	March 19, 1907
Baldwin	858,366	July 2, 1907
F. Shuman	876,307	January 7, 1908
Meyer	876,653	January 14, 1908
Gessner	881,791	March 10, 1908
George & Shortle	891,924	June 30, 1908
George & Shortle	892,044	June 30, 1908
Murnane	901,725	October 20, 1908
Apple & Buttler	902,849	November 3, 1908
Quertinmont	911,679	February 9, 1909
Swearer & Toynbee	915,805	March 23, 1909
Franzen	936,880	October 12, 1909
Arbogast	941,842	November 30, 1909
Hastreiter & Bleilevens	944,861	December 28, 1909
A. Shuman	945,054	January 4, 1910
Franzen	945,316	January 4, 1910
Franzen	945,317	January 4, 1910
Meyer	952,126	March 15, 1910
Baldwin	957,594	May 10, 1910
Temple	959,434	May 24, 1910
Meyer	968,178	August 23, 1910
Blackmore	972,433	October 11, 1910
Francart, Johnston & Couch	976,125	November 5, 1910
Dulles	1,003,093	September 12, 1911
Jungers	1,064,146	June 10, 1913
Wadsworth	1,119,329	December 1, 1914
Quertinmont	1,119,535	December 1, 1914
Franzen	1,135,370	April 13, 1915
Baldwin	1,144,976	June 29, 1915
Duffenbacker	1,149,117	August 31, 1915
Baldwin	1,167,759	February 1, 1916
A. Shuman	1,170,008	February 1, 1916
A. Shuman	1,232,107	July 3, 1917
Dawson	1,341,547	May 25, 1920
Liston	1,466,025	August 28, 1923
Owen	1,583,793	May 11, 1928
Cox	1,592,180	July 13, 1926
Owen	1,644,349	October 4, 1927
Crowley	1,656,048	January 10, 1928
Hastreiter	1,656,583	January 17, 1928

Glass Industry

ESTABLISED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials and Glass Factory Equipment and Operation

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What Price—Glass Houses

WITH the announcement from New York that tests are being conducted looking to the use of glass brick and glass plate, which may enter into the construction of the "Palais De France" building to be erected on Broadway between Sixty-second and Sixty-third streets, the glass industry is confronted with a possible large expansion. We have witnessed, recently, a decided increase in the use of glass for ornamental store fronts, for decorative lighting, also as a building material for indoor construction. If, by this interest, we can judge the public as being "glass minded" and it surely appears so, why not seize the opportunity to begin active research tending toward the use of glass for outdoor building construction?

With the rapid development of glasshouse refractories, machinery and equipment, there appears to be no logical reason why glass in the form of bricks or plates could not be manufactured at a price comparing favorably with other building materials. If, as reported, one or two of the European countries have solved this problem in a small way, there is no reason why, with American ingenuity, competent research laboratories and adequate capital, we could not create and meet the demand in a big way. This has been accomplished with other than clay or stone building materials. Let us take our cue from the aluminum metal industry, which is enjoying marked progress with cast aluminum as a building material, and at a selling price far in excess of clay products.

As to the decorative or aesthetic possibilities of glass as a building material, there can be nothing like it. The surface of glass can be treated, molded or decorated in a manner conducive to the dreams of the best architects and artists of the country. A variety of textures can be given to glass. Through the medium of glass there can be expressed a feeling, a motive, a spirit, in a manner which would bring joy to the greatest of artisans and art lovers. It stands alone in a field where a transparent or translucent effect is involved. For the transmission or dispersion of sunlight, colored or white incandescent light or health giving rays, where is its equal? Glass: pleasant in its feeling, glorious in its color, health giving in its transmission of light, useful in its transparency. What more could the idealist ask?

Glass As a Major Building Material

The use of glass as a major building material will be adopted on a large scale for the first time in America in the new Palais de France to front on Broadway, Central Park West, 62nd and 63rd streets, according to Erwin S. Chanin, head of the Chanin Construction Company of that city. A glass brick and a new type of plate glass in all probability will be used almost exclusively as an outside covering material for the top seven floors of the building.

Designs have been prepared by Frank Lloyd Wright, an architect, for four 18-story apartment buildings to be erected on property of St. Marks in the Bouwerie, New York. From a central core of concrete founded on bedrock, shelves or floors will extend outwardly and on these shelves a copper shell will be constructed with walls of glass in various colors. The buildings will cost approximately $400,000 each.

They will be constructed on the plan of inverted pyramids, in contrast to the prevailing set-back style of architecture. Small abutments projecting outwardly will be constructed as the building is carried upwards, giving the whole an overlapping appearance.

Successful Toronto Meeting of Glass Container Association

THE semi-annual convention of the Glass Container Association was held at Toronto, October 17-19, at the Royal York Hotel. There was a good attendance of members.

Following a preliminary meeting of the Board of Directors on Wednesday, October 16th, the convention was officially opened Thursday morning with a call to order and a speech of welcome by Samuel McBride, Mayor of Toronto.

President Heuisler made a few opening remarks in which he stated his appreciation of the efficient work being done by the various committees and asked for further co-operation in concluding a successful year.

A satisfactory condition of finances was reported by V. L. Hall, assistant treasurer.

Dr. Hugh Baker, head of the Trade Association Department, Chamber of Commerce of the United States, spoke on "The Business Man and His Trade Associations."

Dr. Baker in his talk stressed the fact that there are certain fundamental problems confronting all industries which can only be overcome by united confidence on the part of the leaders in the field and faith in each other among members and that trade associations can go a long way in creating this faith and do much to alleviate unsound situations.

Director of Traffic J. C. Magness made a report at this time on the activities of the group handling that branch of the Association's interests. He was followed by J. T. Hendricks who reported in the capacity of Director of Public Relations on such progress as had been made.

The afternoon session was opened with a statistical report by V. L. Hall on new orders, production, and shipments of glass containers up to August, 1929.

Charles F. Abbott, executive director of The American Institute of Steel Construction, gave an interesting discourse on "Courageous Marketing."

Plans for the continuation of, and a review of the Association's advertising campaign were presented by I. R. Stewart, John S. Barlow, T. Donald McConaughy of the advertising agency of N. W. Ayer & Son.

Friday morning's program was started with a report by the business manager, Charles R. Stevenson, followed in turn by an outline of the progress made in the advancement of new and increased uses for glass containers by H. P. Hartley, W. L. Davis, John S. Barlow, and Norman C. White, who announced satisfactory progress in pushing this particular phase of the work.

Karl S. Ford, Director of Research, told those present of some of the activities of this department under his supervision.

An address followed at this time by H. L. Richeson, vice president and general manager of the Canada Dry Ginger Ale, Ltd., "Why is Canada Dry, the Champagne of Ginger Ales?"

The morning program was concluded by holding closed meetings of the Glass Section and the Cap and Closure Section.

The afternoon and concluding meeting included an address by W. R.. Drynan, general manager of the Canadian Canners. The rest of the time was devoted to reports of the various committees, those being: Report of Tariff Committee, W. R. Leach, Report of Standardization Committee, W. S. Richards, Report of Legislative Committee, E. F. Glacken, Report of Membership Committee, J. H. Graham.

L. S. Cunningham and H. L. Lonsdale were appointed to the Board of Directors.

The convention was successfully topped off socially by a banquet in the evening and a golf tournament Saturday morning at the Toronto Golf Club.

Summary of Charles F. Abbott's Talk

"Woman rules the merchandising world today. Catch a woman wearing things for utility's sake alone! It is the modern woman who most appreciates the new and beautiful; the modern woman who practices courageous spending. She is more progressive than the modern man because she has greater fearlessness and is less easily satisfied."

These were among the novel utterances of Charles F. Abbott of New York, economist and industrialist, in his avowedly frank and straight-from-the-shoulder address. Mr. Abbott is Executive Director of the American Institute of Steel Construction and his addresses throughout Canada and the United States have done much to instill new and progressive thought in business—business sometimes sluggish and backward—and to inspire industry to meet the ever increasing discrimination of the consuming public.

In his address to the glass men, however, Mr. Abbott took occasion to say that their enterprises had adopted a farsighted policy in the matter of blending the beautiful with the utilitarian in the preservation and marketing of foods and beverages and that those commodities, produced in open-face glassware, were a distinct forward step in meeting the demands of exacting women for "better things more attractively marketed."

Mr. Abbott indulged in no sentimental eulogies to womanhood; he talked hard market facts; he cited the evolution in automobile manufacture declaring that the new beauty in design and color was in response to the imperious demands of "woman who rules the merchandising world."

While Mr. Abbott was addressing an audience of men, only, he drew no protests when he said: "Few men are hardy enough to buy even a dog or an automobile or a suit of clothes without bringing their wives along." The speaker was by no means in jesting mood; he was talking of a new pyschology in marketing revealed in this statement:

"It is a silent revolution, a great cultural movement that every educated person has dreamed about and longed for. It is a day when even the servant girl in the kitchen thrills to the beauty of color. A day when the things we turn out of our factories begin to have the beauty of those in the days of handcraft; when buildings and bridges are no longer eyesores but wonderful combinations of service, economy and beauty."

Following up the premise that woman ruled the merchandising world, Mr. Abbott gave it as his belief that women were just a little in advance of what the manufacturer and merchant had to offer to meet those demands. It was in that particular that he pointed out weaknesses in the thoughts and theories of many industries including the manufacturers of glass containers, nevertheless admitting that the men whom he was addressing were at least fundamentally right in their elementary efforts to meet the increasing pressure for more attractiveness as well as more utility in the preservation and marketing of foods and beverages.

With this thought in mind, Mr. Abbott urged more courageousness, more daring even, in expenditures to prepare for the modern housewife the varieties and qualities which modern culture had taught her to require. The speaker clearly was of the opinion that to make money in this day of progress entailed the courage to spend money.

Review of Talk Given by Research Director Karl L. Ford

The purpose of the talk was not to report on all the activities of the Research Laboratory but to outline by a few illustrations certain accomplishments of the laboratory. Since it is an Association laboratory the value to the individual members depends upon the extent to which they use it.

As an example of the scope of the work the following service problem is cited. A technical representative of a company putting out a pharmaceutical visited the laboratory to discuss a spoilage problem. He stated that his investigation had removed all blame from the bottle or closure and that the spoilage was evidently of a chemical nature of the product itself. In a conference with various members of the staff representing different training and specialists in different fields the possibility of bacteriological spoilage was brought out. Later tests confirmed the point.

The simple illustration represents a large part of the laboratory's contacts with consumers. Because of the varied training and experience it is possible for the laboratory acting as a unit to approach a problem from the bacteriological, chemical or engineering point of view, considering all phases rather than only one as is frequently the case.

As an illustration of packing methods the Director related the experience of a firm packing mushrooms. This company had decided to pack some of their product in glass because of the attractive appearance. Their first trial packs were anything but attractive. When the laboratory was called on for assistance they pointed out that while appearance was an essential factor, quality was equally important. This concern

was of the opinion that they should duplicate a foreign glass packed mushroom which had a fine light color. They were convinced that while this product must possess the desired appearance the quality and flavor were below the standard they had set for their product.

It was decided that the laboratory would visit their plant and develop a method of packing mushrooms in glass with flavor and quality as major features and appearance as attractive as possible under these conditions.

An exhaustive study was made and a method developed. Before the laboratory representative left, several packs in glass, of excellent quality and flavor had been put through.

A further illustration was that of a retort in which temperature differences were responsible for spoilage. A salesman of a member company who had attended the salesmen conferences of the laboratory recognized the possibility of faulty retort operation. The laboratory investigated this spoilage problem using thermocouples to study the actual temperature changes within the retort. Some changes were made which resulted in an important improvement in the system.

Further illustrations of work on tomato juice in which Vitamin C determination were to be made on various methods of packing were given. A brief discussion of the laboratory work on processing and heat penetration studies in connection with the California State Board of Health was presented. It was pointed out that the processing of the glass container was an important subject not only as regards a safe product, but for the retention of the original freshness of the product.

Those Present

Glass Container Manufacturers

Ball Brothers Co., Geo. A. Ball, Mr. Petty.
Berney Bond Glass Co., Ben F. Hazelton, Jr., R. L. Kane, A. Wright.
Brockway Machine Bottle Co., W. D. Dugan, A. A. McFadden.
Buck Glass Co., Roy A. Blunt.
Capstan Glass Co., G. F. Rieman.
Carr-Lowrey Glass Co., George F. Lang.
Cunningham Glass Co., D. O., L. S. Cunningham.
Dominion Glass Co., Ltd., I. R. MacDonald, Ralph King, J. W. King.
Fairmount Glass Works, John H. Rau.
Foster Forbes Glass Co., W. C. Forbes.
Gayner Glass Works, John M. Gayner, J. M. Lummis.
Hamilton Co., J. T. & A., James H. Graham.
Hart Glass Co., T. F. Hart, Harry McDonald.
Hazel-Atlas Glass Co., J. H. McNash, J. S. Algeo, W. H. McClure. McClure.
Lamb Glass Co., R. M. Lamb.
Maryland Glass Corp., Philip I. Heuisler, Stanley Heuisler.
Nivison-Weiskopf Co., The, E. L. Miller, Sidney E. Miller.
Owens-Illinois Glass Co., W. E. Levis, Frank Ferguson, James Morrison, W. S. Richards, Harold Boeschenstein, H. G. Phillipps.
Pierce Glass Co., H. C. Herger.
Root Glass Co., C. J. Root, W. R Root.
Salem Glass Works, W. E. Garvey.
Standard Glass Co., C. W. B. Hughes.
Swindell Brothers, Harry O. Brawner.
Thatcher Mfg. Co., H. C. Mandeville, E. F. Wellinghoff.
Turner Glass Corp., H. D. Hartley, Kenneth M. Smith, John Ferguson.
Whitall Tatum Co., Wm. H. B. Whitall, Geo. S. Bacon, J. L. Bacon, H. V. Brumley.
Glass Container Association, C. R. Stevenson, E. G. Ackerman, V. L. Hall, W. L. Davis, J. S. Barlow, N. E. White, J. C. Magness, J. T. Hendricks, K. L. Ford.

Glassmaking Materials and Equipment

Buckeye Clay Pot Co., The, W. K. Brownlee.
Corhart Refractories Co., Fred S. Thompson.
Diamond Alkali Co., F. G. Lancaster, Geo. S. Cooper, A. H. Copeland.
Erwin Feldspar Co., V. V. Kelsey.
Hartford-Empire Co., E. O. Hiller, J. L. Hamill, Roger M. Eldred.
National Mortar & Supply Co., Jno. C. Denison.
O'Neill Machine Co., The, Wilson M. O'Neill.
Overmeyer Mould Co., C. P. Overmeyer.
Pennsylvania Glass Sand Corp., R. F. Riddle.
Pittsburgh Plate Glass Co., Refractories Dept., M. G. Babcock.
Solvay Sales Corp., H. F. Merritt.
Toledo Mould Co., The, Geo. B. Arduser.
United Feldspar Corp., C. H. Peddrick, Jr., Harry A. Richard.
Winkler & Bros. Co., The Isaac, Robert E. Winkler.
Roessler & Hasslacher Chemical Co., Werner Malsch.

Bottlers' and Packers' Supplies and Equipment

Adriance Machine Co., H. M. Ross.
Aluminum Seal Co., J. E. Sharp.
Anchor Cap & Closure Corp., I. R. Stewart, J. O. Deegan.
Brass Goods Mfg. Co., Percy Brown.
Crown Cork & Seal Co., F. L. Lloyd, E. B. Kramer.
Gutmann & Co., Ferdinand, Benno Cohn.
Irvington Varnish & Insulator Co., Chas. E. Garneau.
National Seal Co., H. Wainwright.
Phoenix Hermetic Co., T. L. Taliaferro, H. L. Lonsdale.
White Cap Co., Geo. White.
Karl Kiefer Machine Co., E. E. Finch.
Sealright Co., Wilbur L. Wright.
U. S. Bottlers Machine Co., A. H. Ross.

Miscellaneous

American Institute Steel Construction, C. F. Abbott.
Ayer & Son, Inc., N. W. Donald McConaughy.
Chamber of Commerce, U. S. A., Hugh P. Baker.
U. S. Dept. of Commerce, Division of Simplified Practice, W. E. Braithwaite.
Canada Dry Ginger Ale, Ltd., H. L. Richeson.
Canadian Canners, W. R. Drynan.
Food Industries, M. A. Williamson.
Glass Packer, The, C. O. Watney.
National Glass Budget, A. W. King.
The Glass Industry, Walter W. Watson.

Most Arsenic Produced as By-Product

Arsenic produced in the United States in 1928 was nearly all a by-product of lead and copper smelting, according to a report by the Department of Commerce. Production of arsenic (arsenious oxide) in the United States in 1928 amounted to 14,163 short tons, of which 9,276 tons was refined and 4,887 tons was crude. The production for the market consisted of refined white arsenic, crude white arsenic, "flue" dust and "treater" dust. The chief sources of domestic arsenic are Montana and Utah, where it was recovered from miscellaneous ores and concentrates by the Anaconda Copper Mining Company, American Smelting and Refining Company, the United States Smelting, Refining and Mining Company and the Jardine Mining Company. The White Iron Ores & Products Co. reported shipping two cars of arsenical ore in 1928 from Madera, Colo., to Denver, where special compounds (not specified) containing elemental arsenic were made experimentally. This company's property is on Lake Fork of the Gunnison River, just above Sapinero, Colo. It is equipped with a small arsenic kitchen, but the kitchen was not in use in 1928. Arsenic of the highest grade is usually sold to insecticide and glass manufacturers. The glass industry in 1928 consumed 11 per cent of the production.

Imports of crude and refined arsenic during 1928 amounted to 11,153 short tons valued at $775,169, two-thirds of which came from Mexico. As the sales of domestic arsenic amounted to 11,767 tons, the total new supply on the market in the United States was 22,930 tons. This with the 2,396 tons produced in 1928 but not sold indicates 25,316 tons as the total new supply of white arsenic available during that year.

According to the tariff act of 1922, arsenious acid or white arsenic is on the free list. Under the preceding tariff act of 1913, white arsenic and arsenic acid were both on the free list. The price quoted in New York for white arsenic delivered at the consuming point was steady at 4 cents during all of 1928, but small lots were quoted at a higher price.

The Jardine Mining Co., of Jardine, Mont., and other producers of arsenic in the United States petitioned the Committee on Ways and Means, Jan. 8, 1929, for a duty of 4 cents a pound on arsenious acid or white arsenic; they claimed that large imports of cheap arsenic keep the price much below actual production costs. Production of arsenic direct from ores has ceased, and none of the plants erected for treating ore for arsenic alone are in operation. The cost of such production in the United States is estimated to be between 7 and 8 cents a pound; the cost to the cheapest producer is 6.35 cents a pound, according to W. C. Bacorn, of the Jardine Mining Co.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

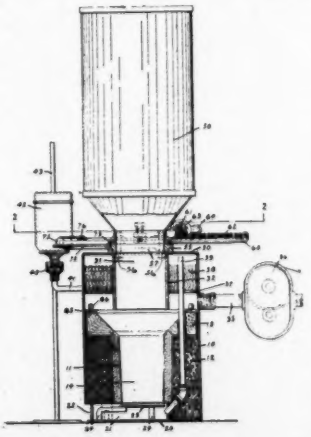
Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

GLASS FEEDER. U. S. 1,731,947. Oct. 15, 1929. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Co., Toledo, O. Filed 6/20/27. In glass feeding apparatus, the combination of a glass tank, a forehearth extending therefrom and provided with a discharge outlet through which molten glass issues, means including a vertically movable gate dividing said forehearth into front and rear compartments, said front compartment having a bottom outlet through which molten glass is discharged, means for directing a heating flame into said front compartment, means including a port above and separate from said gate for directing the spent gases of combusion into said rear compartment and discharging them therefrom to the outside air, and a gate for controlling the passage of the gases through the port.

APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,727,379. Sept. 10, 1929. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company. Filed 5/8/24. Some objects are to utilize confined fluid pressure for restraining the issue of the glass in the intervals between the charge-forming operations, without causing the pressure fluid to impinge directly upon the glass in the discharge outlet; to provide improved means for reheating the shear-scarred stub of glass which remains above the shears after each severing operation; to provide for playing a flame continuously at the edges of the discharge outlet, thereby preventing the glass from chilling at any stage in the formation of mold charges; and to provide convenient means for regulating the pressure of the confined fluid which is effective to check the movement of the glass through the discharge outlet.

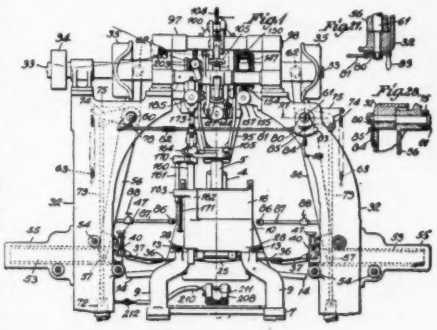
MANUFACTURING GLASS-MELTING CRUCIBLES AND SIMILAR REFRACTORY OBJECTS OF CLAY. U. S. 1,732,088. Oct. 15, 1929. Julius Hochhut, Klein-Freden, Germany. Filed 12/22/27, and in Germany 11/6/25. The process of manufacturing glass melting crucibles and similar refractory articles of clay, consisting in mixing clay with a ground leaning means, moistening the mixture with water only to an extent so as to obtain a loose incoherent mass, supplying said mass in small portions to an open mould while permanently stamping it therein, and drying and burning the shape thus obtained.

GAS PRODUCER. U. S. 1,724,525. Aug. 13, 1929. Harry F. Smith, Dayton, O., assignor to The Gas Research Co. Filed 1/30/22. A gas producer having a shell provided with a fuel inlet opening therein, a member associated with said opening in the shell and having an opening in registration therewith, a slidable plate mounted upon said member having an opening in one end thereof, a removable and portable fuel reservoir having a discharge mouth positioned within the opening in said slidable plate, the other end of said slidable plate forming a closure to completely close off said opening in the shell when the said plate is moved into position for removal of the fuel reservoir, a separate closure plate for the said fuel reservoir removably carried by said member, and clamping means carried by said closure plate, the said closure plate and clamping means being positioned to receive and engage the discharge mouth of the fuel reservoir upon movement of the fuel reservoir to said position for removal to thereby close the mouth of the fuel reservoir to facilitate removal and replacement thereof.



APPARATUS FOR OBTAINING CHARGES OF MOLTEN GLASS. U. S. 1,732,771. Oct. 22, 1929. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn., Filed 4/24/22. Apparatus for separating molten glass into mold charges of different weights, comprising a container having a discharge outlet, mechanism for periodically extruding glass through the outlet, severing mechanism below the outlet, and means for operating the severing mechanism at the end of intervals of different duration in a given cycle.

METHOD OF AND APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,724,678. Aug. 13, 1929. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company. Filed 10/19/23. This invention relates to the segregation and separation of molten glass into mold charges. It has for its object the production of mold charges of suitable form and homogeneity to be most advantageously used in glass shaping machines, and it comprises a method and apparatus whereby such mold charges may be pre-formed while segregating them from a supply of molten glass in a furnace or container, and before bringing their external surfaces into contact with relatively cold molds or other supporting or forming means, and whereby the form and size of such charges may be controlled and varied at will, and without destroying their uniform consistency by the unequal chilling action of external or relatively cold molds or other supports or forming means.

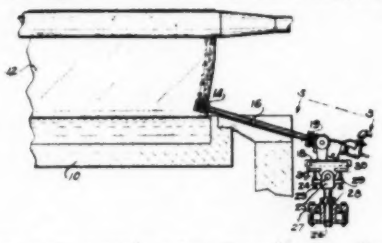


METHOD OF LABELING BOTTLES. U. S. 1,725,199. Aug. 20, 1929. Antonius R. Kuhn, Pasadena, and James J. Furlong, Vernon, Cal. Filed 3/31/28. The invention relates to the placing of the lettering or designs on the inner surfaces of bottles, so that access to such lettering or designs cannot be had so readily for destruction or obscuration thereof. This method it is claimed makes it possible to insert a decalcomania into a bottle and cause the same to adhere in the desired position to the inner surface of the bottle.

GLASS AND PROCESS OF DECOLORIZING AND FINING THE SAME. U. S. 1,726,635. Sept. 3, 1929. William Chittenden Taylor, Corning, N. Y., assignor to Corning Glass Works. Filed 5/11/26. Modification of the process of manufacturing non-splintering glass sheets described and claimed in the specification of the inventor's copending application for Patent No. 306,750. A method of avoiding the trapping of air bubbles between the component sheets of a plurality of compound sheets of glass and cellulose derivative composition conjointly pressed in a fluid-tight bag, consisting in arranging said sheets on edge within said bag, admitting liquid at the bottom of said bag to rise and submerge said sheets, closing said bag, and applying suction initially to the top of said bag prior to subjecting said bag and sheets to said conjoint pressing.

GLASS-WORKING MACHINE. U. S. 1,724,972. Aug. 20, 1929. Paul Schwerin, New York, and John G. Pfeiffer of Union Hill, N. J. Assignors to Bell Telephone Laboratories, Inc. Filed 8/28/26. Relates to glass working machines used in the manufacture of electron discharge devices. An object is to effect automatically the application of vitreous insulating material to wire material, as in the manufacture of small electron discharge devices, to form an elongated glass insulating bead on the supporting wires for the electrodes.

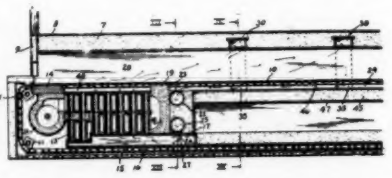
SHEET-CLASS APPARATUS. U. S. 1,731,249. Oct. 15, 1929. Lupe C. Mambourg, Lancaster, O., Assignor to Libbey-Owens Glass Company, Toledo, O. Filed September 23, 1926. In sheet glass apparatus, a receptacle adapted to contain a mass of molten glass, means for drawing a sheet therefrom, rollers engaging both sides



of the sheet at the opposite edges thereof, said rollers being inclined at an angle to the directon of movement of the sheet being drawn, shafts carrying said rollers, a base for supporting said shafts, a bearing member to which the base is pivotally mounted, oppositely directed lugs carried by said bearing member, and adjusting screws and passing upwardly through the lugs and bearing against the undersurface of said base.

METHOD OF AND APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,731,681. Oct. 15, 1929. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 6/7/27. The method of feeding molten glass in mold charges, which comprises flowing glass by gravity downwardly through a submerged outlet of a glass container, periodically accelerating and retarding flow of glass through the outlet by reciprocating an implement in adhesive contact with the glass substantially in line with the outlet, further accelerating and retarding flow of glass through the outlet by imparting expelling and retarding fluid impulses to the glass surrounding said implement above the outlet in timed relation to the accelerating and retarding strokes of the implement, and periodically severing mold charges from successive masses of issued glass in timed relation to the application of the expelling fluid impulses and while such masses are suspended below the outlet.

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE. U. S. 1,714,707. May 28, 1929. Percy Q. Williams, Toledo, O., assignor to the Owens Bottle Company. Filed 3/30/27. The method which consists in passing articles through a lehr tunnel, causing movement of an annealing medium over the surfaces of the articles and in the direction of travel of the articles, reversing the direction of movement of the annealing medium at a predetermined point, lowering the temperature of the annealing medium, and causing the reversed medium to modify the temperature of the lower portions of the articles.



MANUFACTURE OF REFRACTORY COMPOSITIONS. U. S. 1,724,886. Aug. 13, 1929. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company. Filed 6/1/25. The invention aims to improve the manufacture of refractory blocks and other refractory parts by preparing in an improved manner the grog which is commonly employed in refractory compositions, whereby the grog, and consequently the finished refractory, shall be as dense and free from voids as is possible, consistently with long life under operating conditions. The claims include a new article of manufacture, a dry-pressed refractory grog that is capable, when assembled into a refractory block, of withstanding the corroding action of molten glass by reason of the density and freedom from pores imparted to it by dry pressing.

GLASS-SEVERING MECHANISM. U. S. 1,732,305. Oct. 22, 1929. Everett O. Hiller, Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 7/15/25. In combination with a glass feeding device, pneumatically operated shears cooperating therewith, a valve for controlling the admission of fluid pressure to said shear mechanism, mechanical means for interrupting the movement of said shears, and cam-operated means for actuating said valve and for controlling the movement of said interrupter to regulate the closing of said shears.

Glass Competes With Marble

Glass, which is being used more and more in architectural construction, was recently employed in the erection of a mausoleum located at Shelbyville, Indiana. The Marietta Manufacturing Company, makers of Sani-Onyx, the product used in this work, declare that it is a more advantageous material for this type of construction than marble in that it is non-absorbent and consequently does not hold dampness as does marble.

The entire interior of the four-hundred crypt mausoleum was lined with glass. The accompanying photographs give an idea of the appearance and quality of workmanship effected with this medium.

The builders of the mausoleum are highly pleased with Sani-Onyx for this particular purpose and predict that although marble has been used in the past for this type of construction, glass will replace it entirely when once the builders are familiar with its advantages. This product is also being used quite extensively for walls and ceilings in bathrooms, kitchens, and surgeries; for window sills and for wainscoting corridors, lavatories, and toilets of public buildings.

THE SHELBYVILLE MAUSOLEUM

INTERIOR OF GLASS CONSTRUCTION

A New Potentiometer Pyrometer Recorder

A new potentiometer recording pyrometer embodying a number of distinctly new characteristics has been developed by Wilson-Maeulen Company, New York. It has a temperature record chart 12" wide, and other new features of mechanical and electrical design. While employing the potentiometer principle, at the same time it does so with a mechanical simplicity that is unusual for that type of instrument. In this potentiometer recorder, when the measured voltage from the thermocouple changes, as a result of temperature change at the thermocouple, the galvanometer pointer deflects in the corresponding direction.

At intervals of 10 seconds a boom descends and grips the pointer firmly while two sensing fingers, moving in a vertical plane, approach the pointer from each side, exploring for the location of the pointer, and if either finger finds the pointer deflected and away from its central or null position, a roller ratchet dog is released by the finger, causing a drum to turn.

By means of a violin string, wound around the drum and passing over pulleys at each side of the chart, and attached at opposite sides of a carriage, the motion of the drum in either direction is transmitted to the carriage which is adapted to travel back and forth across the whole instrument.

The carriage carries the pen which marks the chart in its travel, and a contact brush that rides on the potentiometer slide wire.

The selective operation of the drum's rotation, both in direction and extent, moves the contact on the slide wire so as to bring the galvanometer back toward its null or undeflected position, and at the same time moves the recording pen to record on the chart the temperature of the thermocouple.

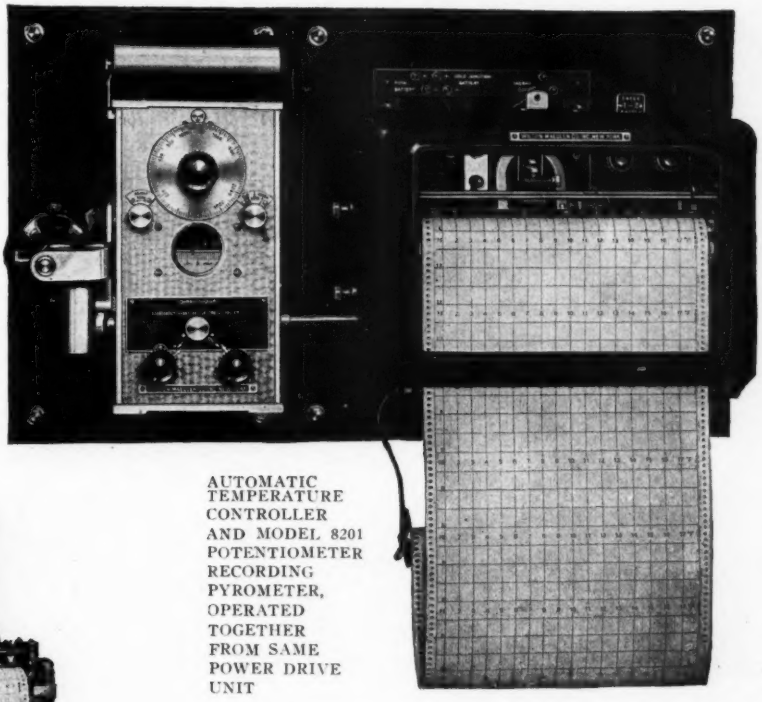
Great width of chart, which provides a very open scale, and extremely legible printing of temperature lines and numbers on the chart, together with the bright and contrasting color of the ink used, makes it possible to read the chart at a considerable distance from the instrument.

A choice of three chart speeds, namely ¾" per hour, 1½" per hour and 3" per hour, permits the user to secure the chart speed most suitable for his needs. On operations where temperature changes are slow and long periods of time are involved, the slow speed condenses the record and makes observation of trends and cycles easier. For rapidly fluctuating temperatures and short cycles of operation, the faster speeds allow more detailed analysis of temperature changes.

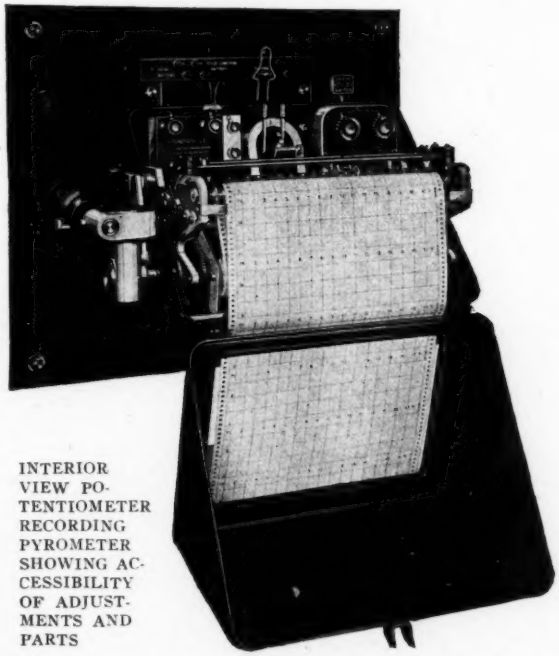
The recording pen and the slide wire contact are integral and cannot get out of relationship to each other.

The recording pen has a metal tube siphon that will stand cleaning and handling without breakage, and an ink reservoir that holds a supply of ink sufficient for an entire record roll.

One of the interesting features is the ink developed by Wilson-Maeulen Company for this recorder. The ink has a brilliant red color and dries quickly on the record before the chart emerges from the case. It does not smear in passing through the paper slot.



AUTOMATIC TEMPERATURE CONTROLLER AND MODEL 8201 POTENTIOMETER RECORDING PYROMETER, OPERATED TOGETHER FROM SAME POWER DRIVE UNIT



INTERIOR VIEW POTENTIOMETER RECORDING PYROMETER SHOWING ACCESSIBILITY OF ADJUSTMENTS AND PARTS

Among the new advantages of this recorder is a provision for easily and quickly adjusting the sprocket at one end of the paper roller as to distance from the sprocket at the other end of the roller. This permits adjustment to accommodate for any variation in the width of the chart paper due to atmospheric conditions.

Changes in the temperature of the thermocouple cold junction are automatically compensated for in the instrument by an electric cold junction compensator, similar to the automatic compensators successfully used on all types of Wilson-Maeulen pyrometers for the past several years.

An external drive unit, consisting of a motor of ample size and a double worm and gear speed reducing system, located outside the instrument case, furnishes power to the instrument mechanism.

This drive unit is identical with the drive unit satisfactorily employed on Wilson-Maeulen automatic temperature controllers for a number of years, and is supplied with this recorder for either 110 volts or 220 volts alternating current.

The drive unit provides ample power for operating more than one instrument, and the design is arranged so that a group of recorders, or a group combining this recorder and the Wilson-Maeulen automatic temperature control pyrometer, can be operated by one drive unit.

Charts are available for a wide selection of scale ranges, in both Fahrenheit and Centigrade scales, to suit the various types of thermocouples and to suit the various temperatures of industrial operations, not only in glass plants but many other industries.

For low temperature operations, from 600° F down to 0° F or lower, this same recorder is supplied to operate as an electric thermometer employing resistance bulbs.

The instrument case opens diagonally, making the entire mechanism easily accessible. This accessibility includes the slide wire, which is wound on a straight rod, located in front just above the chart where it is easily cleaned. Slide wires are easily and quickly removed and replaced and are conveniently interchangeable.

Heavy and rugged construction and well machined parts are in evidence throughout.

One of the accessories obtainable is a storage roll and holder, which fits underneath the recorder, for rolling up and holding the used portion of the chart.

A new catalog section, numbered P-5-1, fully describing and illustrating this recorder, has been issued by Wilson-Maeulen Company, 385 Concord Avenue, New York, and is now available.

New Tests of Ultraviolet Ray Transmitting Glass[1]

Exhaustive tests conducted both in England and on an ocean steamer exposed to blazing sub-tropic sunlight have developed new evidence on the permanency of transmitting powers of ultraviolet ray window glass, and, the authors state, have entirely upset previous tests by proving them founded on false hypotheses.

The tests were conducted by the Research Laboratory of the Crown Glass Works at St. Helens, England. It was developed that:

1. The chemical stabilization process (solarization) of ultraviolet ray window glass takes place in a few days in natural sunlight.
2. There is a definite level at which the transmitting power of the glass stabilizes and remains fixed.
3. Solarization tests conducted by *artificial* light are not conclusive.

Solarization of ultraviolet glass by artificial means, it was shown, causes far more of a loss in the transmitting power of the glass than could be possibly caused by exposure to natural sunlight. Further, it was demonstrated that such artificially solarized glass when exposed to sunlight actually regained what it had lost through the excessive exposure to artificial rays.

One of the tests proving this was done as follows:

Two pieces from the same sheet of ultraviolet were taken. On being tested, untreated, they were found to have a transmitting value of 58½ per cent. One of the pieces was subjected to artificial solarization. Its value dropped to 33 per cent.

Both pieces were then exposed during very fine weather, being placed on the top of a building. After six days, two of which were dull, the piece of glass that had not been subjected to the artificial rays was found to have attained a transmission value of 46 per cent. The artificially solarized piece, however, was found to have improved from the original 33 per cent. to 43½ per cent. After twenty-four days, both pieces had a transmission of 45 per cent., and after thirty-two days it was still 45 per cent.

From this test it will be seen that solarization by natural sunlight entails a loss of less than 25 per cent., instead of the much higher figures that had been made public as the result of tests made with ultraviolet machines.

Further investigations along the same line revealed that:

(1) When kept in the dark, glasses solarized by the quartz mercury lamp do not regain any of their lost transparency.

(2) Glasses thus solarized, when exposed to sunlight, regain some of their lost transparency.

(3) Glasses thus solarized, when covered with ordinary window glass and exposed to sunlight, regain some of their lost transparency.

(4) Glasses thus solarized, when covered with a thick layer of ordinary window glass, and further exposed to the mercury vapor lamp, regain a similar amount of their transparency quite rapidly, the change being more rapid with a thick covering of ordinary glass than with a thin.

In conclusion, the investigation reported: "We consider that these figures prove conclusively how completely misleading has been the use of the mercury vapor lamp by investigators to determine the loss in transparency of glasses when exposed to natural sunlight."

That hitherto published results of tests made with ultraviolet lamps have been prejudicial to ultraviolet glass is thus natural. A widely circulated questionnaire recently revealed the fact that, while the large majority of medical men to whom it was addressed were convinced of the permanence of ultraviolet glass, many, because of the mercury vapor lamp tests, believed that the glass declined in transmitting value. Results of the St. Helens tests, establishing the permanency of fixation, are as follows:

Original Transmission (per cent.)	After Complete Solarization by Quartz Mercury Lamp (per cent.)	After Subsequent Exposure of Solarized Glass to Sunlight (per cent.)
59	35	47 (5 days' exposure)
59	32½	45 (5 " ")
60	32½	45 (9 " ")
59	31½	48 (9 " ")
35½	25	31 (9 " ")
35½	25	31½ (3 " ")
		After Subsequent Exposure to Sunlight Under Ordinary Window Glass
57½	32½	44 (5 days' exposure)
		Further exposed to Lamp Shielded by Ordinary Glass
75½	52½	58½ (8 hrs. exposure)
66	35	46 (8 " ")
66	38	47 (8 " ")

Another test involved sending specimens on a ship to Madeira and back. These specimens experienced very brilliant weather. Glasses of two different compositions were taken, and two specimens of each, one being new glass and the other glass completely solarized by the mercury lamp. Glasses widely different in transparency were chosen. The following are the figures for the transmission of these four specimens, before and after the voyage:

	New Glasses			Artificially Solarized Glasses	
	Original (per cent.)	At end of Voyage (per cent.)		At Beginning of Voyage (per cent.)	At end of Voyage (per cent.)
A	56	43	A	29½	43
B	34½	29½	B	24	29½

It is significant that the two specimens of glass A, one untreated and the other artificially solarized, finished the voyage with identical transmissions, the falling off of one being of the same magnitude as the recovery of the other. The same is true of glass B, which is of very much lower transparency, and of entirely different composition.

[1] From the Ultra-Violet Glass Information Bureau, New York, conducted by the Vitaglass Corporation.

Laminated Glass Now Being Made in Japan

A special laminated glass composed of two sheets of glass with a thin sheet of celluloid is now being manufactured in Japan, the Department of Commerce has learned from its office in that country. Glass used in the manufacture of this product has been imported either from the United States or Czechoslovakia and in small quantities from Great Britain, while the celluloid is a Japanese product. Plans are going forward for the manufacture of thin plate glass in one of the Japanese glass factories and it is expected that this product of Japanese manufacture will soon be on the market.

It is stated that the patent is owned by the Minister of the Army, and the product of the factory is approved for army and navy use. At the present time this glass is produced in only one specification; that is, five millimeters thickness, twenty-four inches in width and forty-eight inches in length. The product of this factory is sold at 4 yen per square foot ex factory, the yen par at .485 cents, packing and shipping charge being for the account of the buyer.

Hydraulic Wash-Out System Used in New Glass Sand Plant in Oklahoma

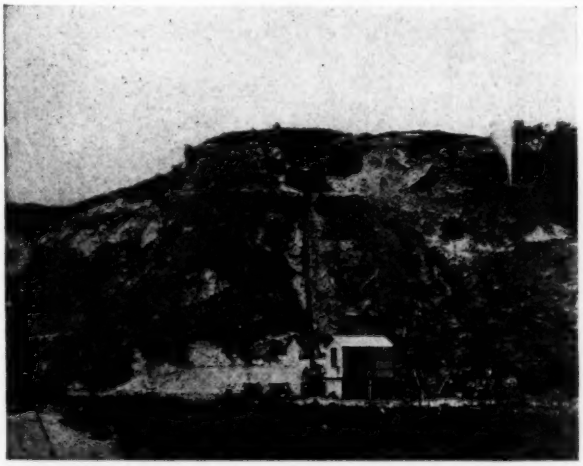
The new glass sand producing plant illustrated herewith has just been completed and is reported ready for operation at Randolph, Oklahoma. Randolph is located about 100 miles southeast of Oklahoma City on what is known as the Red River Main Line of the 'Frisco Railroad and on the branch line of the Rock Island Railroad. The plant is of the most modern design and construction and an important innovation is the washing out of the sand by hydraulic pressure which eliminates all steam shovel work and trucking. Its present production capacity is from 10 to 12 carloads per day and it is so designed that at a comparatively small cost the production capacity can be increased to handle 20 to 40 cars of sand per day.

There are two areas in Oklahoma containing sand of sufficient purity to be used for the manufacture of glass. One area consists of the outcrop of the Simpson sandstone extending from near Bromide west closely flanking the axis of the Arbuckle Mountains. The other area consists of the outcrop of the lowest bed of the cretaceous formation situated along the south side of the Arbuckle Mountains.

The holdings of the Randolph Silica Products Company are located three-fourths of a mile from the station at Randolph and three miles southeast of the village of Russet. The sand outcrops on the holdings of the Randolph Silica Products Company as an escarpment over 150 feet high capped by a thin bed of soft limestone. The following is a cross-section of these beds starting at the base of the limestone cap rock:

Glass sand	25 ft.
Clay	20 ft.
Glass sand	40 ft.
White plastic refractory clay	45 ft.
Glass sand	25 ft.
Blue plastic refractory clay	

On the land held here by the Randolph Silica Products Company, prospecting and drilling have shown that about 200 acres are



WASHING SAND OUT OF BANK HYDRAULICALLY

underlaid by the above formations so it may be seen that the deposit is practically inexhaustible. The upper 25 feet contain over 6,000,000 tons of glass sand.

Not only is the purity of the sand to be considered in its desirability for glass manufacturing, but, also, the size of the grains is of importance as this has considerable influence on its ability to flux. The coarser the sand, the more readily will it melt. Screen analyses show sand from the Randolph Silica Products Company considerably coarser than any now produced in the state.

The following analyses are results obtained by glass manufacturers in their laboratories from samples of Randolph sand:

	No. 1	No. 2	No. 3	No. 4
SiO_2 (Diff.)	98.73	99.38	99.43	98.94
Fe_2O_3	.07	.06	.05	.09
Al_2O_3	.77	.31	.27	.55
TiO_2	.06	.04	.05	.13
CaO	.04	.01	.01	.02
MgO	.03	.01	.01	.02
Loss	.30	.19	.18	.25
	100%	100%	100%	100%

SUMP BOX AT CREEK LEVEL

Screen Test

On 12	None	None	None	None
On 16	None	None	None	None
On 30	None	None	None	None
On 60	17.0	5.2	6.0	.1
On 100	41.0	74.8	71.0	10.5
Through 100	42.0	20.0	23.0	89.4
	100.0%	100.0%	100.0%	100.0%

The market for glass and silica sand in Oklahoma is one of steady growth, in keeping with the increased number of glass factories in the state. In 1913 there was a consumption of from

SAND PUMP HOUSE

1 to 2 cars per day. Today there is a daily demand for from 10 to 12 cars with new plants being built which will probably increase this to 15 cars per day by the end of the present year. Not only is silica sand used for the manufacture of glass, but it has many

other uses. Many tons are used every day in Oklahoma as foundry sand, being imported from eastern states. It is also used in considerable amounts as an abrasive. Furnace lining and smelter retorts require silica sand and several cars per day pass through Oklahoma for points in Texas, New Mexico and Mexico. Pulverized silica is also used in many industries.

To take care of the above market for silica sand, the plant was constructed at Randolph. The location is excellent with good railroad facilities as it is but ½ mile from the large electric substation of the Oklahoma Gas & Electric Company, and located on Oil Creek which furnishes an abundance of pure water for pumping, washing and other purposes.

The sand was originally mined in the pits, but it was found that it might be washed out of the bank hydraulically, thus doing away with the labor of five or six men in the pit. From here it is passed through a screen flowing by gravity through a 12-in. pipe through another screen into a sump box at the level of the creek. Here it is picked up by the sand pump and carried 520 feet to the plant. This pumping scours the sand clean from all dirt or impurities which might cling to the individual grains of sand. At the plant the sand and water flow into a Telsmith dewatering tank where the water is removed and the sand dumped into a Link-Belt dewatering screw. Here the sand is again rinsed and water drained, the sand being delivered onto an 18-inch belt conveyor which delivers it into the draining room. After draining, the sand is moved by a pivoted drag conveyor onto a stationary belt conveyor which feeds it into a 5x40 foot oil-fired revolving kiln which removes all of the remaining moisture. This kiln delivers the sand onto a screen which feeds into a bucket which elevates the sand to the top of the storage bins, feeding into another 18-inch belt conveyor which delivers the finished product into any of three bins which have a total capacity of 7 cars storage.

In the plant above described, the same pumps will handle 40 to 50 tons of sand an hour into the draining room. Conveying and drying units will handle from 20 to 25 tons an hour. In this way, the demand requiring it, the pumps could handle sufficient sand during a 10-hour shift to keep the dry kiln running continuously. The plant is electrically equipped, all machinery being driven by individual motors. It is well lighted and night work can be carried on without inconvenience. All of the construction in the plant is

PART OF PLANT FOR DEWATERING, DRAINING, DRYING, STORING GLASS SAND

either steel or concrete which is designed to carry considerably larger loads than necessary. The trackage is taken off the Frisco Railway and is sufficient to hold 15 to 16 cars. The steel is heavy, the ties especially good and laid in a 10-inch bed of gravel ballast. The local trains handle the switching of the cars, but should an emergency arise a switch engine is available at Madill.

Report on Simplification of Carbonated Beverage Bottles

A meeting of the joint committee on Simplification of Carbonated Beverage Bottles was held in the office of Junior Owens, secretary of the American Bottlers of Carbonated Beverages, Washington, D. C., September 16, 1929.

The following members of the committee and government representatives were present: Chas. E. Culpeper, The Coca Cola Bottling Company of New York, Inc; L. S. Cunningham, Jr., D. O. Cunningham Glass Company; J. P. Curran, The American Bottle Company Division, Owens-Illinois Glass Co.; Carl A. Jones, president, Dixie Coca-Cola Bottling Works, and president, American Bottlers of Carbonated Beverages; Junior Owens, secretary, American Bottlers of Carbonated Beverages; W. S. Richards, Owens-Illinois Glass Company, also chairman of Standardization Committee of Glass Container Association.

For *U. S. Department of Commerce:* W. E. Braithwaite, Division of Simplified Practice, Bureau of Standards; H. B. McCoy, Specialties Division, Bureau of Foreign and Domestic Commerce.

A consolidated report, prepared by the Division of Simplified Practice, showing the variety in capacities, heights, diameters, and weight of glass, as reported by 23 bottle manufacturers, was studied and the following sizes (capacities) heights, diameters, and weights of glass were unanimously recommended for adoption as standards:

SODA AND IMPORTED GINGER ALE SHAPES

(Small Bottles)

Capacities	Height	Diameter (Minimum)	Diameter (Maximum)	Weight of Glass
6	7¾	2⅛	2½	12 or 14
6½	7¾	2⅛	2½	14
7	7¾	2⅛	2½	14
8	8⅛ or 8¾	2¼	2⅝	14 or 16
9	9¼	2⅜	2¾	16
10	9¼	2⅜	2¾	16
16	9⅞	2½	2⅞	16

(Large Bottles)

24	11½	3⅛	3½	24 or 26
26	11½	3⅛	3½	26 or 28
28	11½	3¼	3⅝	28 or 30
30	11½	3¼	3⅝	30 or 32
32	11½	3⅜	3¾	32

Water and Water Shape Ginger Ales

				*Weight of Glass
7	8	2⅛	2½	10
13	9⅞	2½	2⅞	14
24¾	11½	3⅛	3½	23 or 24

* These recommendations on weight are for original filling and not for refilling.

Beers, Export, Select or C. S. Shape

11 or 12	9½	2⅜	2¾	14
24	11½	3⅛	3½	24

The committee members present unanimously voted that the Division of Simplified Practice of the Bureau of Standards, U. S. Department of Commerce be requested to arrange for a general conference of manufacturers, distributors, and users of carbonated beverage bottles to consider the adoption of a Simplified Practice Recommendation covering a standard line of carbonated beverage bottles.

The committee further recommended that the general conference be held in Atlantic City on Sunday afternoon, November 10, just prior to the Convention of the American Bottlers of Carbonated Beverages.

Making a 70-Inch Glass Telescope Disk

Details of the procedure followed in making a glass disk 70 inches in diameter and 11 inches thick for use as a reflector in an astronomical telescope, by A. N. Finn, Senior Scientist, Bureau of Standards, Washington, D. C., are given in research Paper No. 97 consisting of 20 pages reprinted from the Bureau of Standards *Journal of Research*, Vol. 3, August, 1929. This reprint has just been issued and is for sale by the Superintendent of Documents, Washington, D. C., at 10 cents a copy.

The account includes the making of the pots, the modifications in the construction of the melting furnace, the construction of the mold and annealing furnace, the methods of measuring and controlling temperatures, the melting and casting of the glass, essential data on annealing the glass, the determination of the quality of annealing (the amount and distribution of the residual strain), and the drilling of the hole to accommodate a Cassegrainian mounting.

The Glass World and What It Is Doing

News of the Industry

Glass Division Program Discussed Informally

A dozen or so of the members of the Glass Division of the American Ceramic Society, including a number recently appointed to the several Division committees by Chairman J. T. Littleton of Corning, N. Y., gathered early on October 5 at Washington, D. C., by invitation of Francis C. Flint of Washington, Pa., and motored to Mr. Flint's summer cottage at Cove Point, Md., near the lighthouse of that name on the western shore of Chesapeake Bay about 65 miles from the Capitol.

SOME OF THE TECHNOLOGISTS HARD AT WORK ON CHESAPEAKE BAY

The primary purpose of the gathering was to hold an informal week-end discussion relating to the program for the annual meeting of the Glass Division next February at Toronto. Suggestions were also made as to methods for extending the activities of the Division, increasing its effectiveness and influence and promoting a greater interest on the part of the glass manufacturing industry in its activities.

The informal character of the meetings made it possible to discuss questions and arrive at conclusions with much more celerity than would have been possible at a formal gathering and at the conclusion of the event the experiment was heartily commended by those present.

In the party were: Francis C. Flint, Hazel-Atlas Glass Company, Washington, Pa.; J. T. Littleton, Corning Glass Works, Corning, New York; Wm. C. Taylor, Corning Glass Works; E. Ward Tillotson, Assistant Director, Mellon Institute, Pittsburgh, Pa.; W. F. Brown, Libbey-Owens Glass Company, Toledo, Ohio; F. W. Preston, consulting engineer, Butler, Pa.; D. D. Schurtz, Sharp-Schurtz Company, Lancaster, Ohio; A. K. Lyle, chemist, Hazel-Atlas Glass Company, Washington, Pa.; G. E. F. Lundell, U. S. Bureau of Standards, Washington, D. C.; A. Q. Tool, physicist, Bureau of Standards; Herbert Insley, Bureau of Standards; G. E. Merritt, physicist, Bureau of Standards; C. G. Peters, physicist, Bureau of Standards; G. W. Cooper, New York.

SOMEBODY TOOK A "SHOT" AT THEM—WITH THIS RESULT

Decision Rendered in Feeder Infringement Suit

A decision in the Hartford-Empire Company's feeder infringement suit against the Nivison-Weiskopf Company was rendered by Judge Hickenlooper on October 8. Certain newspapers carried items to the effect that the Court ordered the dismissal of the bill of complaint as to all patents in this suit, but it is stated on the authority of the Hartford-Empire Company that this report is not correct.

The Hartford Company alleged infringement of 31 claims of its patent No. 1,573,742 to Karl E. Peiler. These claims relate to glass feeders and this patent is commonly known as the "phase-changing patent." It was held that the ten method claims, and the twenty-one apparatus claims on which suit was brought, were valid and infringed.

Two additional patents were involved in this suit, these being No. 1,564,909 to Steimer, and No. 1,589,304 to Peiler. It was alleged that 6 claims of the Steimer patent were infringed, and one claim of the Peiler patent, but the Court ordered the bill of complaint to be dismissed as to these two patents.

Owens-Illinois Merger Plans Approved

Plans for the merger of the Owens-Illinois Glass Company of Toledo and the Continental Can Company, New York, a three million dollar consolidation which will operate under the title Continental Containers, Inc., were approved by the directors of the two companies in New York on October 9. The deal was handled by Harry E. Collin of Collin, Norton & Co., and William E. Levis, vice-president and general manager of the Owens-Illinois Company. The board of the holding company will include the directors of both of the present companies. Both companies, it is stated, will retain their individual identities operating under present managements and in separate fields.

Progress of Libbey-Owens Process in Belgium

The item printed on page 229 of the October issue regarding an increase in the capital of the Compagnie Internationale pour la Fabrication Mecanique du Verre was wrongly referred to in the heading as a "New Belgian Fourcault Plant". The company referred to operates the Libbey-Owens process and not the Fourcault process as indicated in the headline. The increase in capital from 60,000,000 to 100,000,000 francs is being devoted to the erection of a new plant which will have a capacity of 6,000,000 square meters when its full equipment of six machines is completed. The initial equipment will consist of only four machines. The present Libbey-Owens installations at Moll are now producing 12,000,000 square meters of glass annually with twelve machines, so that the extension of the company's manufacturing facilities now under way will eventually give it an increased capacity of 50%.

Making Business Calls by Airplane

On October 15th, G. K. Fry, vice-president of the H. C. Fry Glass Company, of Rochester, Pa., used a plane as a means of transportation to make calls on some of the customers of the company in several middle West cities.

The plane was owned by Col. H. C. Fry, Jr., president of the Aerial Rapid Transit Company, which company was organized to operate passenger and mail lines between Pittsburgh, Washington, D. C., and other cities.

The party starting on the trip from the landing field at Beaver Falls, was composed of Arthur Lynch, general manager of the Aerial Rapid Transit Company; P. J. Coral, ex-sheriff of Youngstown; Bill Jones, pilot, and G. K. Fry.

A southern route was followed to Dayton, a distance of 315

miles. The elapsed flying time was two hours and forty minutes. The plane used was a Stinson Detroiter, six passenger cabin type monoplane. The ship landed in Dayton after an enjoyable trip from Beaver Falls, and the late afternoon was spent in inspecting some new models of air craft, being built by the Government at Wright Field. In the evening, the plane was hopped over to the Wilbur Wright field, at Fairfield, Ohio, where it was left for the night.

The trip was made over the southern part of Pennsylvania and Ohio, which is more or less rugged country. At the time the trip was made, the leaves had all turned to various colors, and the effect, when viewed from an altitude of 2,000 feet, was gorgeous.

The entire countryside seemed to be covered with a huge blanket of wild flowers, of various hues and colors.

Mr. Fry states that in all his flying experience, and he has about 750 hours in the air to his credit, this trip was the most beautiful and the most enjoyable.

Holding Company for Belgian Glass Factories

The Department of Commerce at Washington recently received a report from Consul Wm. C. Burdett at Brussels, Belgium, stating that all factories engaged in the manufacture of window glass by the Fourcault process, have combined and a holding company has been formed for the purpose of creating, acquiring, developing and exploiting companies using other processes for producing glass both in Belgium and abroad. The consolidation is being backed by the Banque de Brusselles, which controls the organization, and conferences are being held in order to develop a closer understanding between the glass factories and groups formerly outside the syndicate. The entire trend is toward combinations and centralized control of financing, operating and selling.

The Belgium plate glass industry, it was explained, is extremely strong, especially as to its financial position, and production is on the increase. Approximately 90 per cent of the output is being exported at present.

Priestley Lecture Announcement

The School of Chemistry and Physics, in cooperation with the Ceramics Department of the School of Mines and Metallurgy of The Pennsylvania State College, announces the fourth annual Priestly lectures to be given by Dr. Navias, research ceramist of the General Electric Company. These lectures will be held the evenings of December 16, 17, 18, 19 and 20 in the Chemistry Amphitheatre, State College, Pennsylvania.

The five lectures will be grouped about the general topic "The Relation of Physical Chemistry to Ceramics."

Lecture No. 1 will deal with a survey of the field of ceramics showing by numerous examples the dependence of ceramics upon physico-chemical principles.

No. 2 with the vitreous state—glasses, glazes and enamels.

No. 3 with the properties of some important natural materials such as silica minerals, clays and feldspars.

No. 4 with porcelain and similar bodies.

No. 5 with shaping refractory oxides. The artificial production of sapphires.

Owens-Illinois Glass Company

Owens-Illinois Glass Company has declared a dividend of 50 cents on common, payable November 15 to stock of record October 31.

The company states that distribution of 50 cents is an interim adjustment dividend and is not to be considered as an extra payment.

Dividends have been paid at the rate of $1 per share quarterly on the first days of January, April, July and October, the last dividend having been paid October 1. It is the purpose of the board to make the quarterly dividend payable hereafter on the 15th day of February, May, August and November. The dividend of 50 cents a share payable November 15 is for the half quarter from October 1 to November 15 and equalizes the setting forward of the next dividend date from January 1, 1930, to February 15, 1930.

E. C. Larsh's glass sand mining and drying plant at Roff, Okla., was recently damaged by fire.

New Glass and Ceramics Products Company

An announcement of interest to the glass and ceramic trades is the formation of a new corporation in the Pittsburgh district to be known as the Ceramic Products Development Company.

Frank C. Mahoney, an outstanding personality in the colored brick field, and Irving E. Adams, the well known consultant on glass problems, will be associated with the new concern in consulting capacities.

It is understood that very excellent manufacturing and experimental facilities are available to the new concern and that new products of interest to glass, enamel, pottery, terra cotta and heavy clay products manufacturers will soon be available.

Large Increase in Plate Glass Production

The production of polished plate glass for the month of September, 1929, was 14,010,681 square feet, making the total for the third quarter of 1929, 41,790,106 square feet, as compared with 33,022,654 square feet produced in the third quarter of 1928. These figures were compiled by P. A. Hughes, Secretary of the Plate Glass Manufacturers of America.

Trade Mark Bar Adopted by Senate

The Senate, a few weeks ago, adopted a committee amendment to the tariff bill to bar the importation of goods manufactured abroad but bearing American trade marks. The Senate then adopted another committee amendment to prohibit entry of foreign-made goods, the patents on which are owned by Americans.

Decision Not Yet Announced in Safety Glass Suit

In the patent infringement case of the Triplex Safety Glass Company of North America vs. the Pittsburgh Safety Glass Company, now known as the Duplate Corporation, which went to trial on September 3, no decision has been handed down up to the time of going to press with this issue.

Trade Activities

The DuPont Viscoloid Company, Inc. of Wilmington, Del., has begun construction of an addition to its Leominster, Mass., plant for the manufacture of transparent pyralin sheeting for use in safety glass. New buildings and equipment for the production of the superior quality required by the safety glass industry will be constructed, the machinery having been designed by DuPont engineers after thorough research. The additional installation which is estimated to cost approximately $1,000,000 will be completed in the summer of 1930.

The Federal Trade Commission announced on October 16 that the Federal Court has held commercial bribery to be an unfair method of competition. The U. S. Circuit of Appeals for the Sixth Circuit, Cincinnati, Ohio, has entered a decree affirming an order of the Commission against the Grand Rapids Varnish Company, Grand Rapids, Mich., prohibiting the practice commonly known as commercial bribery, and a compliance therewith. This is the first instance on record of such a decision being made by a Federal Court.

The Owens-Illinois Glass Company, Huntington, W. Va., according to the manager, D. Horne Andrews, are installing a fifth Lynch automatic bottle machine which was removed from another plant. The new operation will result in increasing the total force to approximately 850 workers. Previous to this year the plant was operated occasionally with two furnaces only.

The Piedmont Glass Company, Statesville, N. C., was recently incorporated to manufacture, sell and otherwise deal in plate glass, etc. Authorized capital stock $100,000, subscribed stock, $10,000, by Claude Martin and C. F. Williams of Statesville and L. J. Marshall of High Point, N. C.

Baker Brothers Glass Company, Okmulgee, Okla., have just started their 44th consecutive year after a period of complete renovation of their operating department, resulting in a number of refinements to insure and increase quality production and absolute flatness.

Illinois Pacific Glass Company, San Francisco, Cal., declared quarterly dividends of 50 cents each on class A and B stocks payable November 1 to stock of record to October 20.

The Blackford Window Glass Company, Vincennes, Ind., resumed operations on October 15 after a three months shut down. Fires were lighted about three weeks earlier. Within a short time it is expected that a force of 225 men will be working.

Libbey-Owens Glass Company on October 24 declared a dividend of 25 cents per share on each no par share of the company's outstanding stock payable on the first day of December to holders of record on November 15, 1929.

Wells Glass Company, Kokomo, Ind., manufacturers of opalescent, cathedral and figured glass, recently changed the name of their organization to the Wells Corporation. William M. Wells is president.

J. R. Greenlee Company, Wheeling, W. Va., stock and equipment were purchased at public auction early in October by the Standard Plate Glass Company, the principal creditor of Pittsburgh for $11,000.

Pederson Glass Company, Lumberport, W. Va., is reported to have obtained permission to increase their capital from $100,000 to $250,000.

The Sterling Glass Novelty Company was recently incorporated at Morgantown, W. Va., by C. C. Romine and W. G. Kemper.

Recent Deaths

Charles Boldt

Charles Boldt, for 25 years a leading business man of Cincinnati, O., died suddenly in the Hotel Plaza, New York, on the morning of October 2. He with his associate, Fred W. Schwenck, had assisted in completing the merger of the Owens-Illinois Glass Company in Toledo, of which they were directors, and the Continental Can Company, New York.

Mr. Boldt started his career as a clerk in a post office in 1889. When but 20 he organized the Muncie Glass Company at Muncie, Ind., and began the manufacture of bottles. In 1900 he moved to Cincinnati and opened the Charles Boldt Glass Works. Numerous additions were made to the factory and in 1911 a second plant was erected doubling the capacity of the first. Equipped with the most modern automatic machinery including the Owens automatic blowing machines, the company manufactured all sorts of bottles, labels, caps and other supplies. In 1926 the Boldt Company merged with the Owens Bottle Company of Toledo. In the Spring of this year Boldt figured in the second merger when the Owens-Illinois Glass Company was formed and now this organization has been combined with the Continental Can Company. Charles Boldt was 61 at the time of his death.

James A. Swearer

James A. Swearer, 90 years of age, well known glass manufacturer and inventor of wire glass making machinery who was active in the industry for 40 years, died on October 23 at his home in Dormont, Pa.

Andrew Boerner

Andrew Boerner of Massillon, O., died September 18 at the age of eighty-four. For a number of years he was general manager of the Rhodes Glass and Bottle Company, retiring from that position ten years ago.

John Edward Hill

John Edward Hill, manager of the Lancaster Glass Company passed away on the morning of October 10 at 9 o'clock at his home in Lancaster, Ohio.

Coming Meetings

A. B. C. B. Annual Convention at Atlantic City. Immense preparations are being made this year for the annual convention of the American Bottlers of Carbonated Beverages which is to be held at Atlantic City, November 11-15. The place of meeting is the mammoth Atlantic City Auditorium and Convention Hall and contemporaneously there will be held the usual large and varied display of the latest improvements in bottling machinery, equipment and supplies. One and one-half fare tickets will be sold by the railroads. Prominent speakers are scheduled to address the various meetings which are to be held. A number of bottle manufacturers have renewed exhibition space.

What the World Wants

Specific inquiries for American Goods Received in the Department of Commerce, Washington, D. C.

Japan—41345, Glass—cathedral, opalescent, rolled figured, etc., for use in ornamental stained windows.

England—41346, Polished plate glass and glass for store-front glazing.

Uruguay—41354, Heavy type drinking glasses.

Inquiries Received

For further information address THE GLASS INDUSTRY

473. Please explain the meaning of the word "verging" used in connection with glassworking operations.

474. Where can we obtain special colored glass for use in peepholes of kilns.

475. We should like to obtain machines for pressing curved spectacle lenses.

476. Where can we obtain samples of glass, which, from long exposure to the sun have turned to a violet color because of its content of manganese.

READERS' WANTS AND OFFERS

BOTTLE AND TABLEWARE DESIGNER

WANTED:—Highly qualified designer of glass factories for bottle, and tableware, thoroughly acquainted with construction of furnaces, feeders, lehrs, etc. Position in the South of Soviet Russia. Apply to Mr. Morris Holtman, c/o Amtorg Trading Corporation, 261 Fifth Avenue, New York City.

LYNCH MACHINE OPERATORS

WANTED:—Several Lynch Machine operators, highly qualified for service in the South of Soviet Russia. Apply to Mr. Holtman, c/o Amtorg Trading Corporation, 261 Fifth Avenue, New York City.

For Sale: **CULLET** of all Descriptions
Free from Caps, Wires, etc.
GEORGE F. BAUMANN, Dealer,
1110 Carroll Street, Brooklyn, New York.
Carloads Ready for Immediate Shipment.

The New York Public Library in order to complete its files, desires to obtain copies of The GLASS INDUSTRY—issues of Vol. 2 (1921) May, June, and August numbers. Will anyone in possession of these copies and willing to part with them kindly address The GLASS INDUSTRY, 50 Church Street, New York.

Also Wanted: Issues of Vol. 4 (1923) February and October numbers. Issue of Vol. 9 (1928) January number.

GLASS PLANT BARGAIN

For Sale or Lease
on
Startling low terms

Completely equipped glass plant for wide-mouth and pressed and blown ware, also adaptable for diversified line. Convenient to raw materials. Excellent shipping facilities. Low taxes. Delightful living conditions; plant and location offers every desirable feature for manufacturer who desires to expand or relocate his plam. Detailed information on request.

Massillon Industrial Commission
Massillon, Ohio

Current Prices of Glass-Making Materials

October 21, 1929

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.38
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.21-.22
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09⅝
Antimony oxide (Sb_2O_3)	lb.	..	.12-.14
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.05
Barium carbonate ($BaCO_3$)			
Precipitated	ton	57.50-59.50	60.00-61.50
Natural, powdered, imported	ton	45.00	50.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.04¾-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08½
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	..	..
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.02½-.02¾	.02¾-.03¾
Boric acid (H_3BO_3)	lb.	.05½-.05¾	.06-.07
Refined	lb.	.05½-.05¾	.06-.07
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.00-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.24	.25
Cobalt oxide (Co_3O_4)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.28-.30
Black prepared	lb.	..	.30
Cryolite (Na_3AlF_6) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.	..	.09¼
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	11.00-13.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.08¾-.09¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.04
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.094	.10¼
Litharge (PbO)	lb.	.084	.09¼
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	6.50-9.50	..
Burnt (CaO) ground, in bulk	ton	8.00	..
Burnt, ground, in paper sacks	ton	10.00-11.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07
Manganese 85% (MnO_2)	lb.	.04	.04½
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¾
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.16	.16½
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.23
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.90-2.00
Silver nitrate ($AgNO_3$) (100 oz.) per oz.		..	.34¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.80
In bags	Per 100 lb.	1.37½-1.40	1.62½
Spot orders .025 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.90	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	03⅞	.04½
95 per cent.	Per 100 lb.	2.11	2.30
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50
Sulphur (S)			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.39	.37½
Tin oxide (SnO_2) in bbls.	lb.	..	.44
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.50-2.00
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to September 24, 1929

	August 1928 Quantity	August 1928 Value	August 1929 Quantity	August 1929 Value	Eight Months Ending August, 1929 1928 Quantity	Eight Months Ending August, 1929 1928 Value	Eight Months Ending August, 1929 1929 Quantity	Eight Months Ending August, 1929 1929 Value
Glass and glass products (Total)	.....	766,985	.....	798,823	.....	6,556,280	.....	7,292,270
Plate and window glass—								
Window glass, common, box 50 sq. ft.	466	3.801	849	6,183	10,626	65,899	12,165	71,453
Plate glass, unsilvered, sq. ft.	171,670	39,662	133,465	50,132	1,494.016	441,403	1,393,009	494,838
Other window and plate glass lbs.	413,268	37,819	349,159	39,396	2,215,488	245,363	3,021,918	327,759
Glass containers (bottles, vials and jars)	.....	266,580	.....	281,393	.....	2,401,489	.....	2,422,619
Table glassware, plain	.....	101,497	.....	113,312	.....	875,391	.....	990,226
Table and other glassware, cut or engraved	.....	9,022	.....	8,570	.....	100,059	.....	77,874
Lamp chimneys and lantern globes lbs.	132,391	26,363	128,311	24,436	1,211,463	240,989	1,115,762	225,173
Globes and shades for lighting fixtures lbs.	220,791	64,656	114.184	42,352	1,181,212	422,545	1,346,993	490,971
Chemical glassware lbs.	14,830	13,920	104,151	23,323	137,336	124,422	247,670	153,223
Electrical glassware, except for lighting lbs.	239,584	20,864	199,204	23,352	3,103,734	251,035	3,910,704	313,815
Other glassware	.....	182.801	.....	186.374	.....	1,387.685	.....	1,724,319

IMPORTS

Corrected to September 24, 1929

Glass and glass products	.....	1,669,998	.....	1,296,829	.....	9,745,464	.....	9,360,795
Cylinder, crown and sheet..								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case..dut. lb.	4,615,324	179,968	1,179,091	47.766	24,258,784	736,087	27.675,129	742,024
Weighing 80 pounds or over per case...dut. lb.	1,848,376	93,088	2,017,657	76.376	21,556,110	969,161	23,972,020	898,331
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered....dut.	.....	51,453	.....	33,774	.....	362,702	.....	388.970
Plate glass—								
Polished, unsilvered dut. sq. ft.	1,343.754	287,102	905.715	180,721	10,277,237	2,232,408	7,155,909	1,510,867
Other dut. sq. ft.	211,830	60,816	83,427	27,132	1,158,892	302,458	955,070	191,789
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	26,909	.....	17,544	.....	153,573	.....	163,209
Table and kitchen utensils dut.	.....	27,994	.....	34,632	.....	183,322	.....	198 683
Glassware, cut or decorated dut.	.....	307,654	.....	359,166	.....	1,740,586	.....	2,093,381
Blown glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	327,907	.....	244,673	.....	1,072,323	.....	1,081,436
Bulbs for electric lamps dut. No. 1	2,296,812	26,716	1,682,903	18.753	10,075,163	107,662	11,188,178	100,365
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	86,883	.....	59,812	.....	598,906	.....	579,140
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	52,876	.....	64,965	.....	369.057	.....	438.821
Other glassware dut.	.....	140,632	.....	131,515	.....	917,219	.....	973,779